NVIS Antenna

How to get saturation coverage in the skip zone

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Ed Bruette, N7NVP

Problem statement

- State RACES Officer needs to be able to reliably communicate with W7EMD at Camp Murray & other sites around the state via HF on 75 mtrs (Pri.) and 40 mtrs (Sec.)

Goal

- Traffic quality statewide communications using a single transportable antenna and a 100 W transmitter ***without an external tuner***

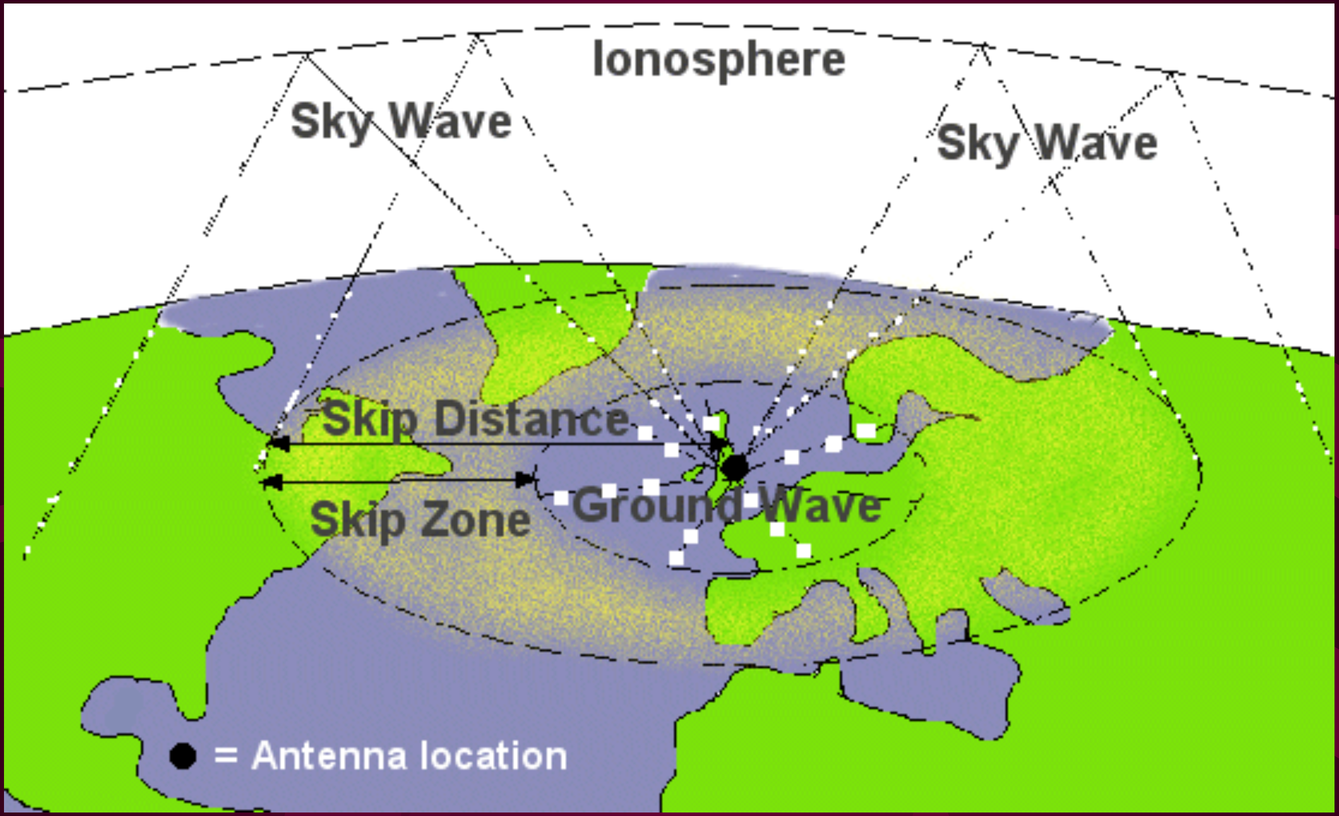
Desirable attributes

- Resonant at 7245 kHz and 3985 kHz
- Omni-directional
- Coverage of WA, OR, ID and BC
- Portable
- Easy for one person to erect

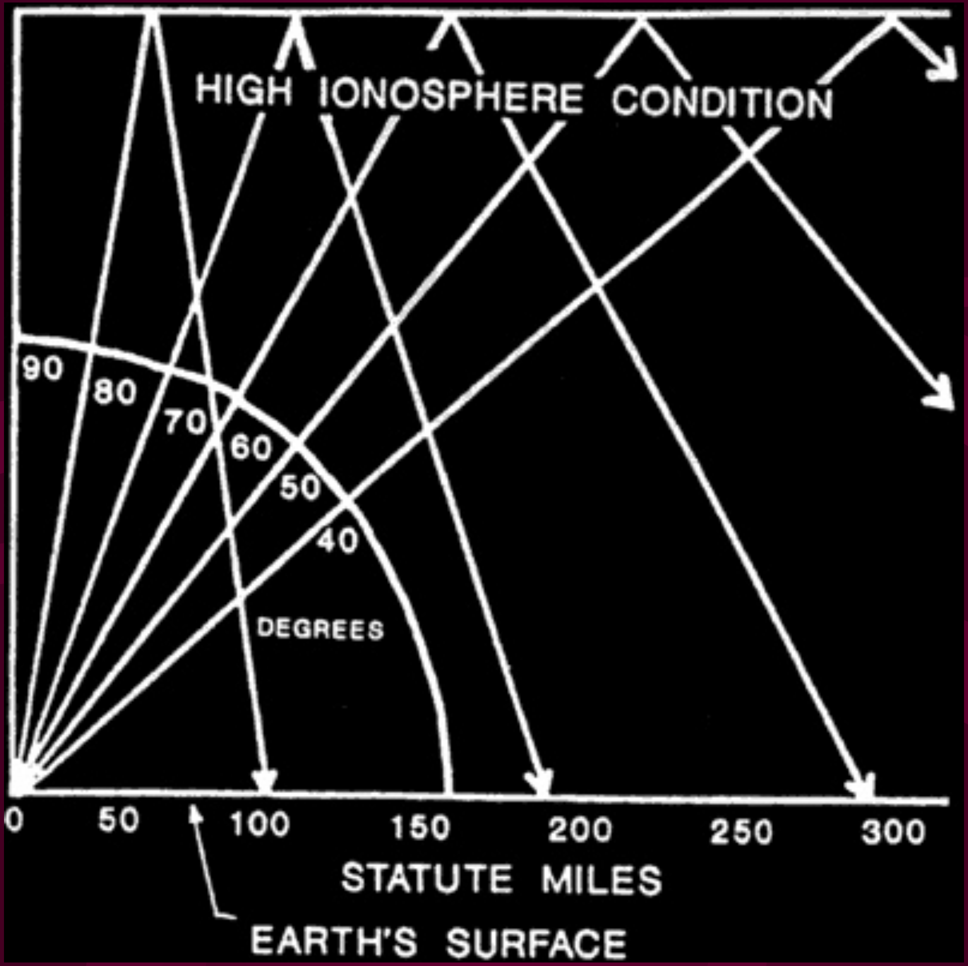
What is NVIS?

- Near
- Vertical
- Incident
- Skywave

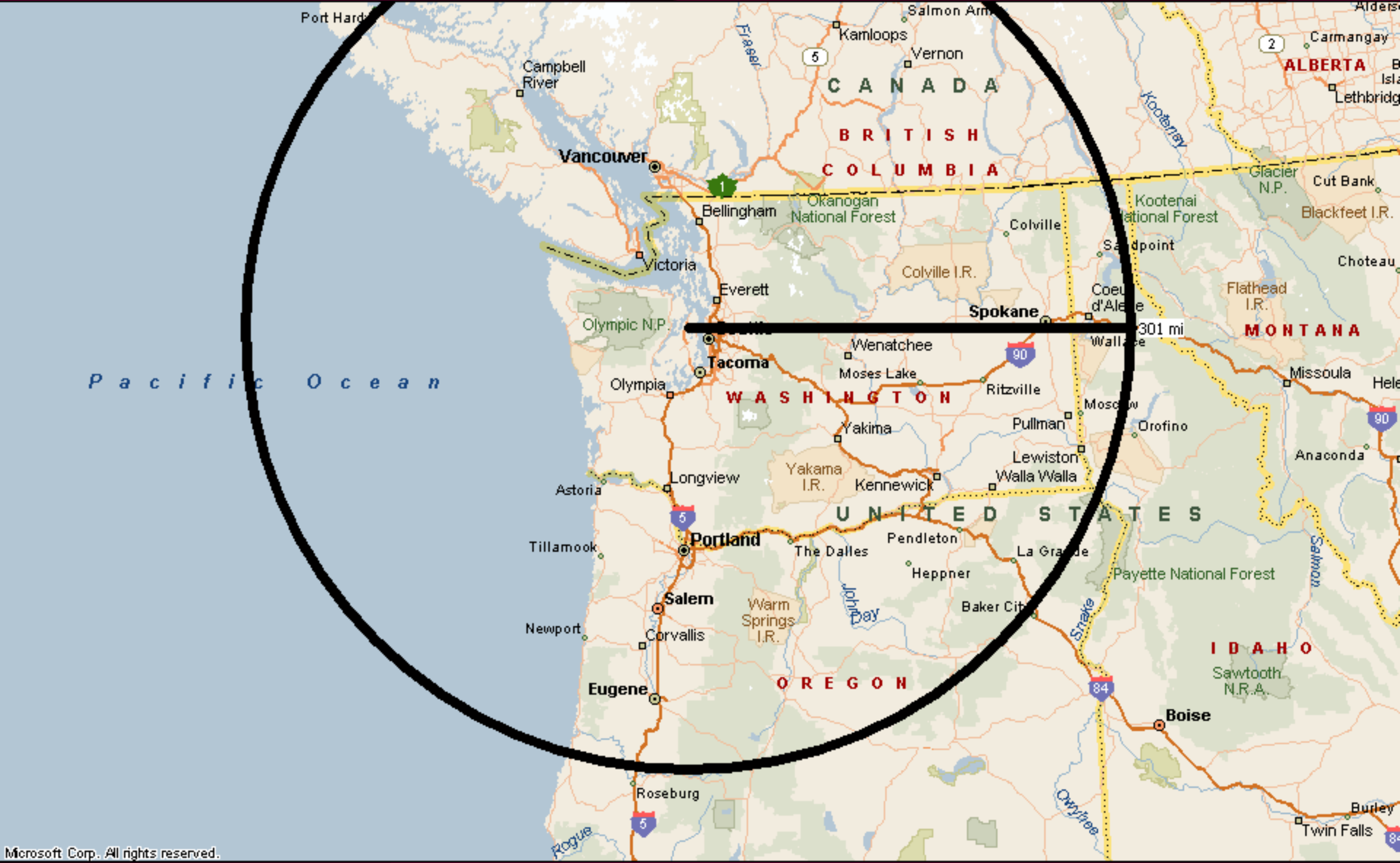
- Cloud Warmer


Ionosphere
Sky Wave
Sky Wave
Skip Distance
Skip Zone
Ground Wave
● = Antenna location

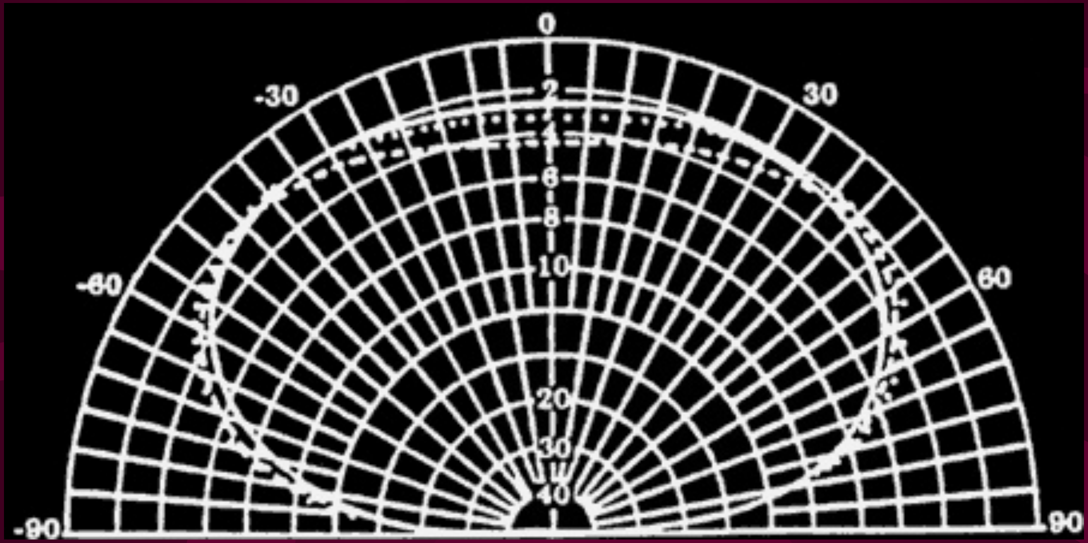
NVIS Effect


HIGH IONOSPHERE CONDITION
DEGREES
STATUTE MILES
EARTH'S SURFACE

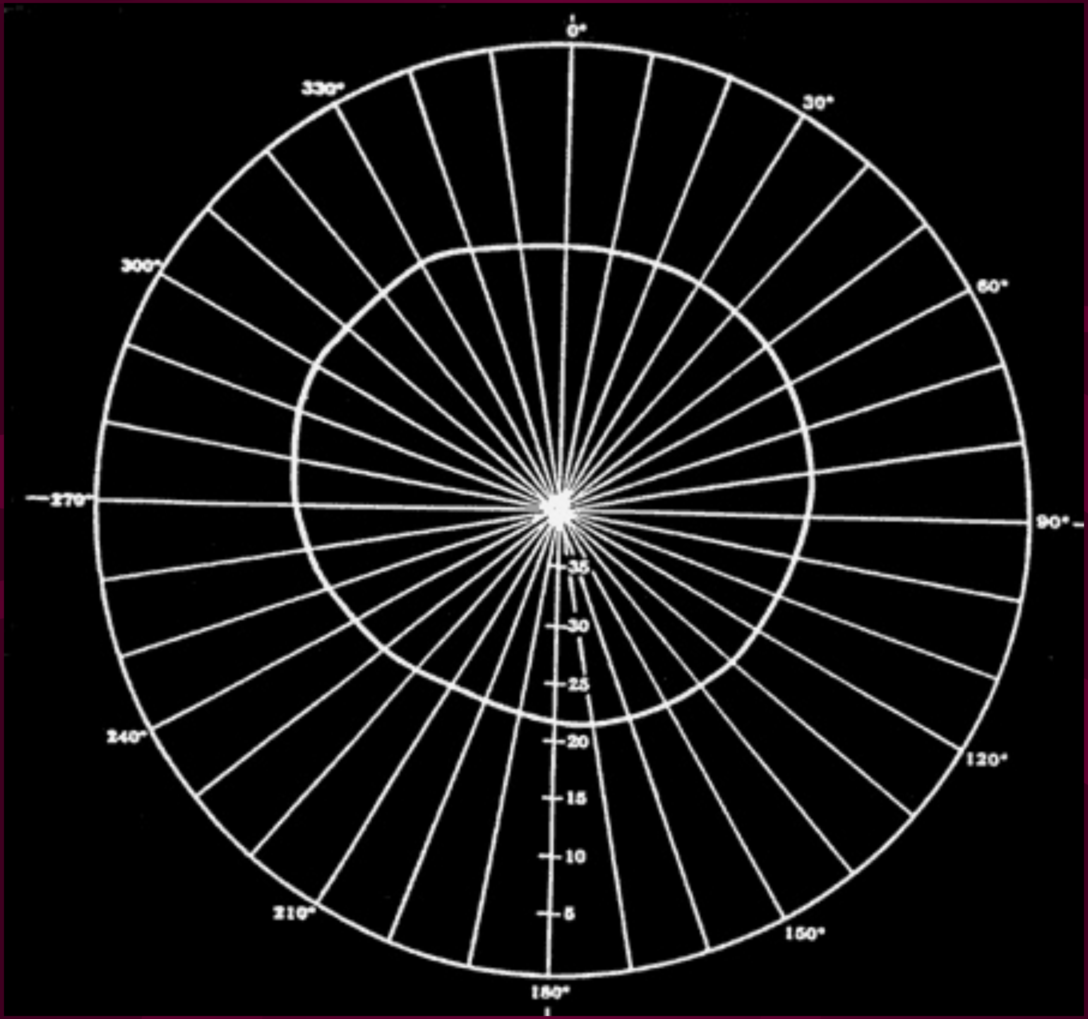
300 Mile Coverage



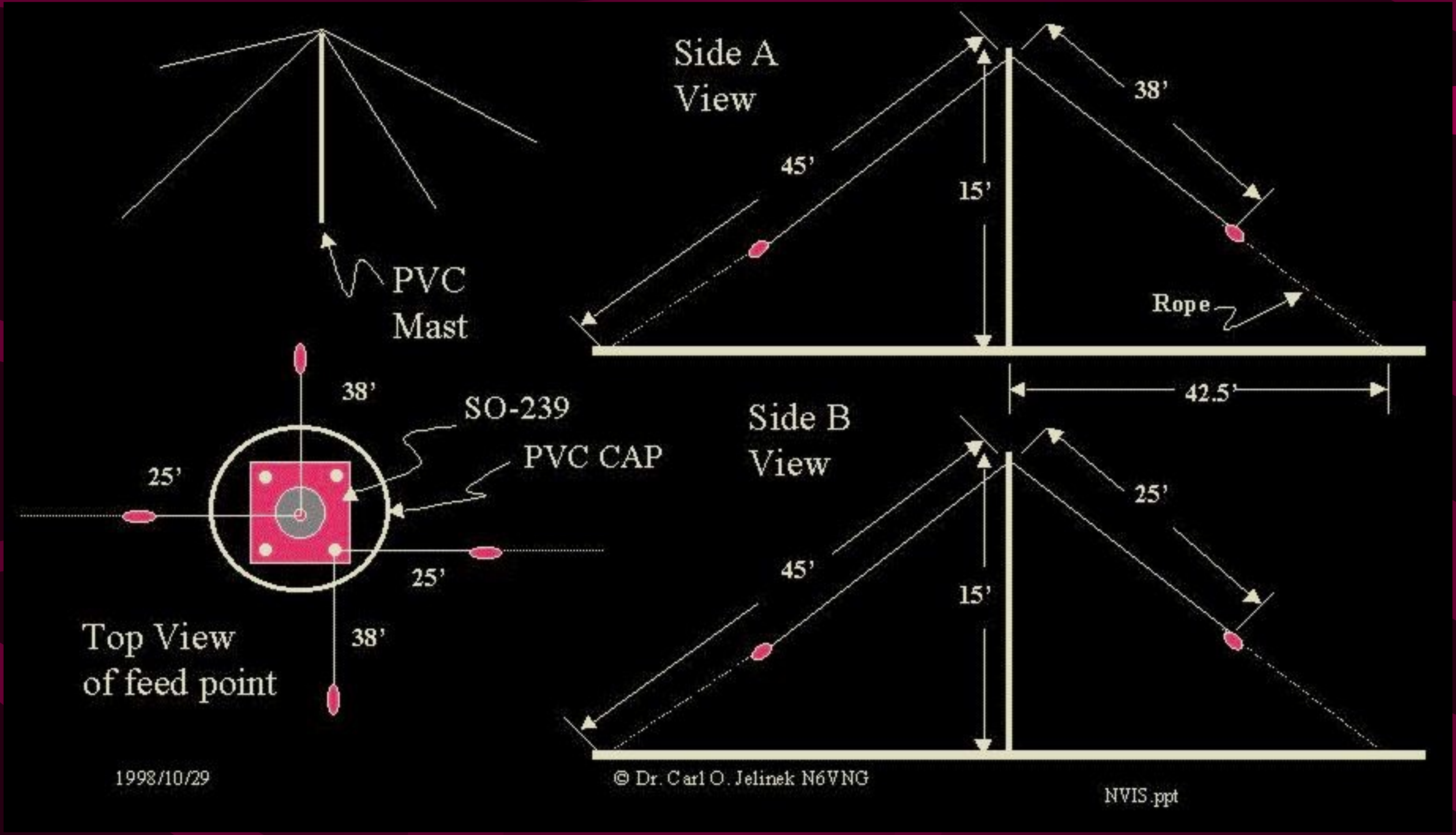
Vertical pattern



Horizontal pattern



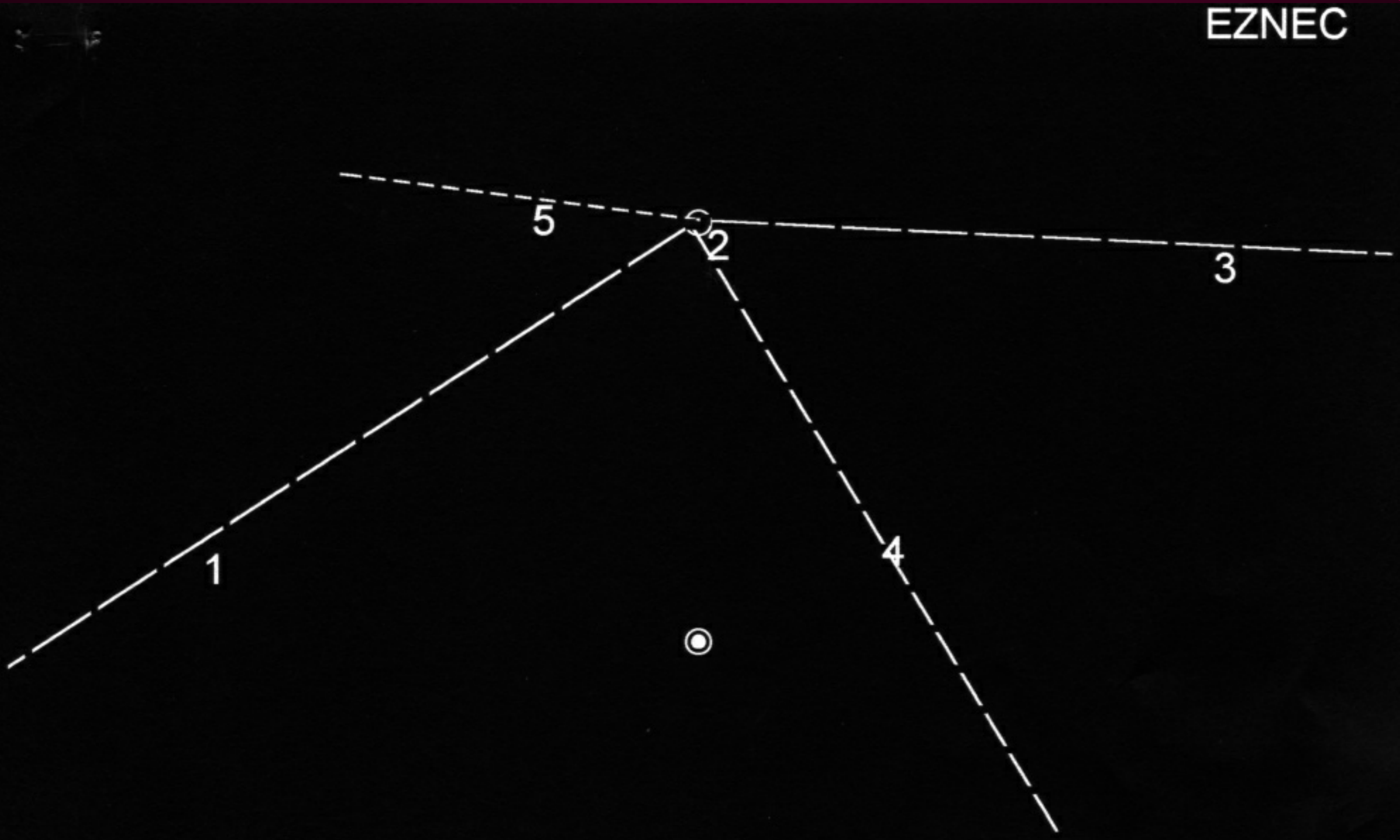
Drawing of original concept



The technical end of things

- Analyzing Dr. Jelinek’s design
- Modifying the original design to work on 75 & 40 without a tuner
- Tweaking for optimum performance

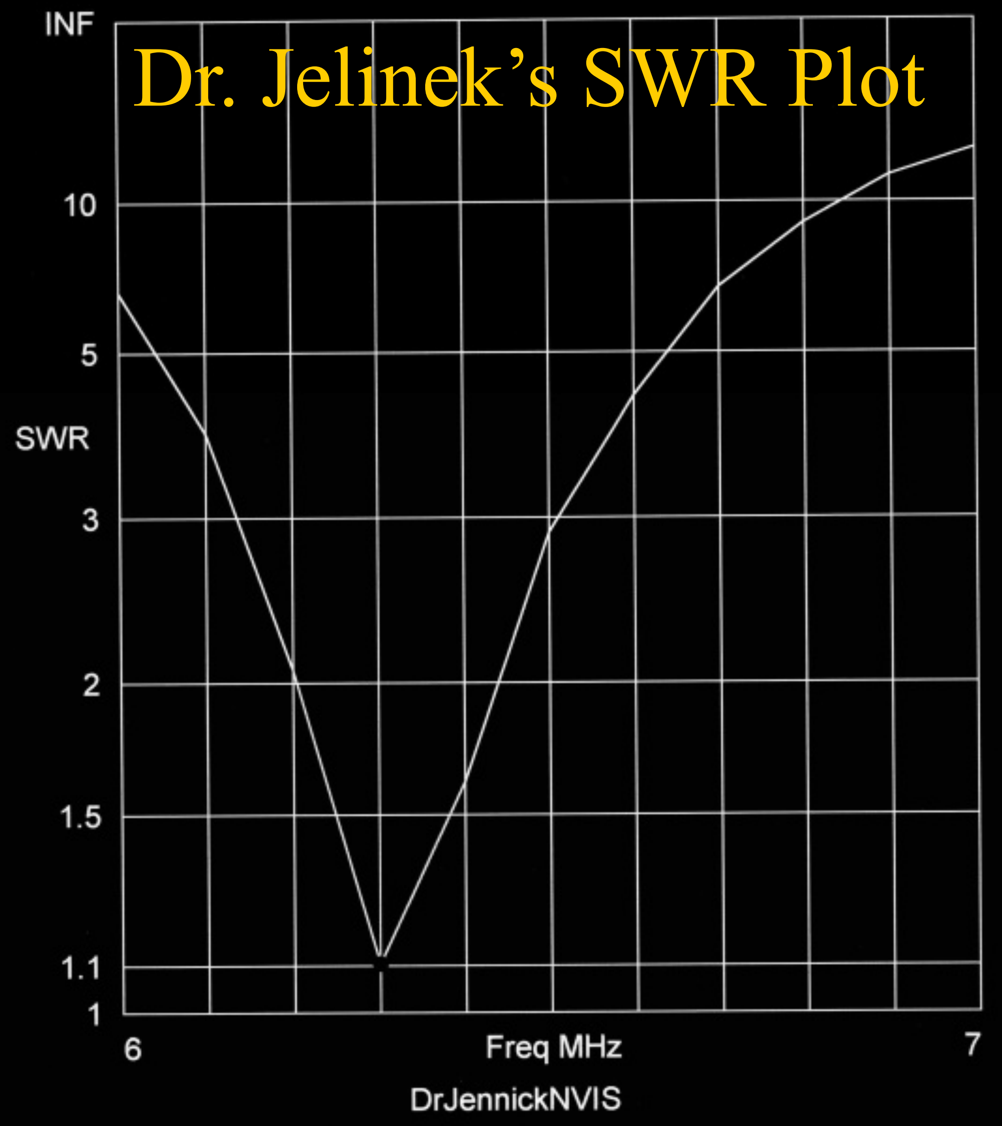
Dr. Jelinek’s antenna



EZNec Considerations

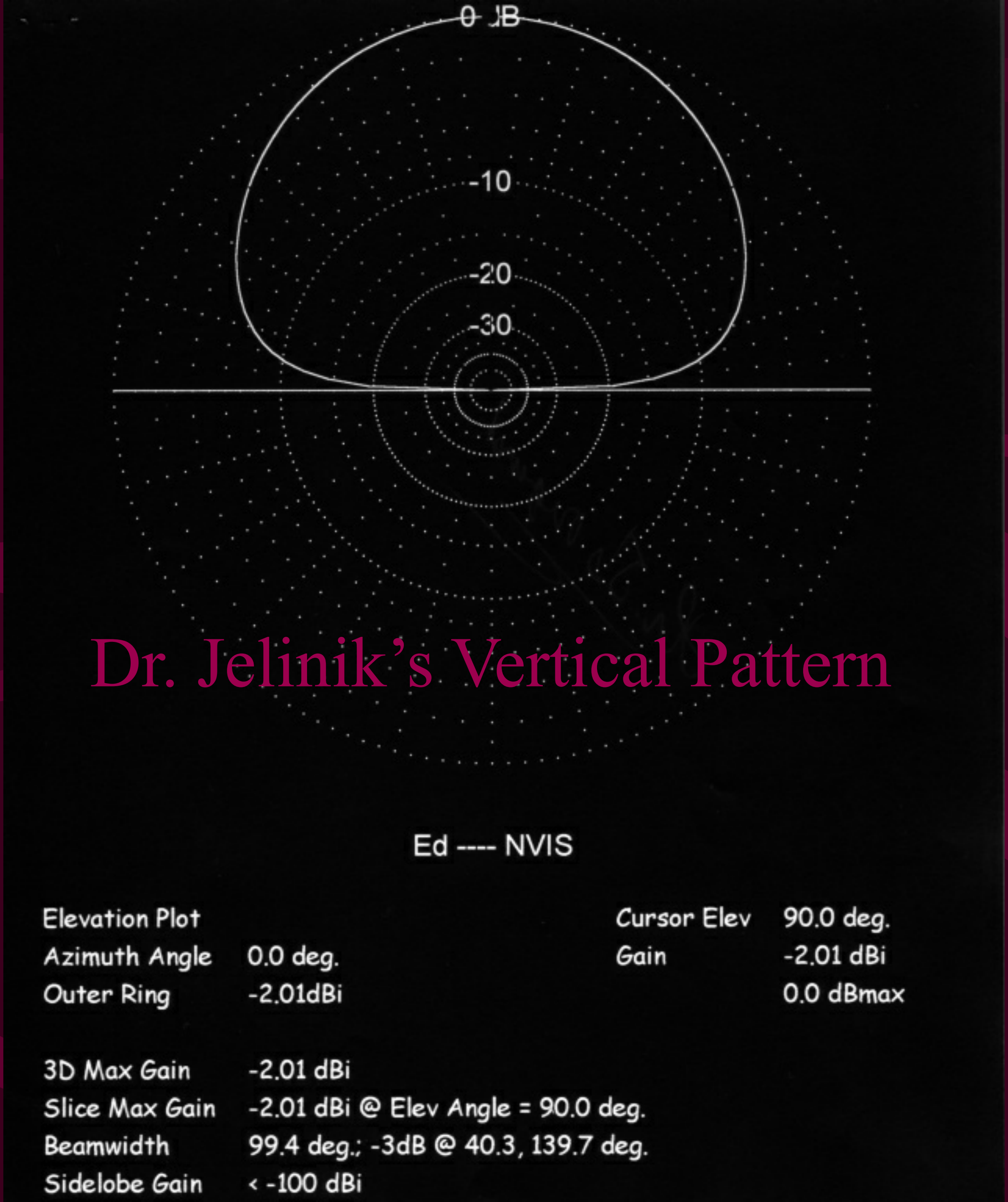
- Derived from original NEC (Numerical Electromagnetic Code)
- Misleading results less than .2 wavelength above ground
- Gain figures vary with ground conditions
- Disregard gain figures

Dr. Jelinek’s SWR Plot



Freq	6.3 MHz	Source #	1
SWR	1.1	Z0	50 ohms
Z	52.07 - j 4.652 ohms		

Dr. Jelinik’s Vertical Pattern

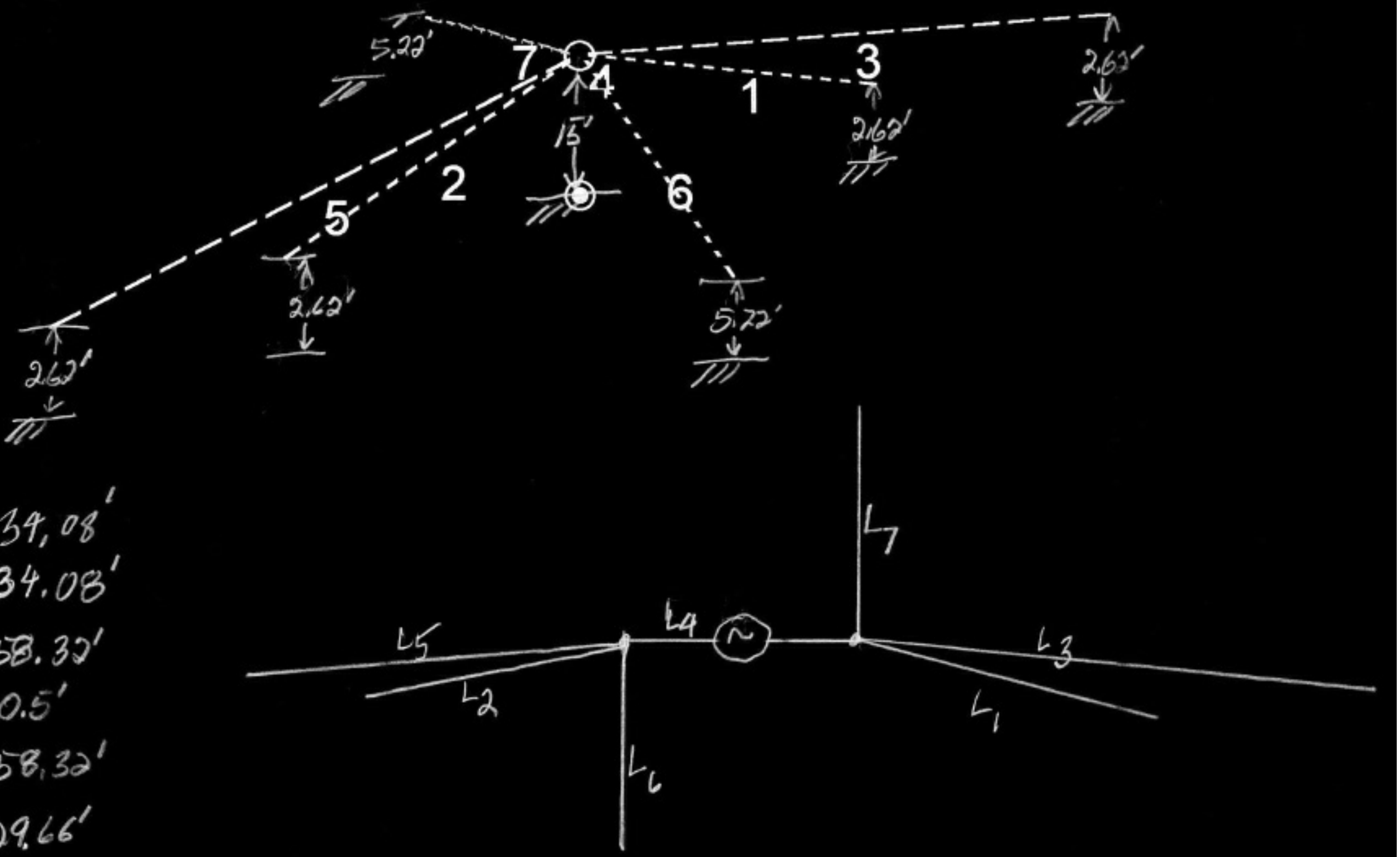


Ed ---- NVIS

Elevation Plot
Azimuth Angle 0.0 deg.
Outer Ring -2.01dBi

Cursor Elev 90.0 deg.
Gain -2.01 dBi
0.0 dBmax

3D Max Gain -2.01 dBi
Slice Max Gain -2.01 dBi @ Elev Angle = 90.0 deg.
Beamwidth 99.4 deg.; -3dB @ 40.3, 139.7 deg.
Sidelobe Gain < -100 dBi



$L_1 = 34.08'$

$L_2 = 34.08'$

$L_3 = 58.32'$

$L_4 = 0.5'$

$L_5 = 58.32'$

$L_6 = 29.66'$

$L_7 = 29.66'$

40 & 75 Mtr version

Ed ---- NVIS (DUAL BAND)
(3.985/7.268)

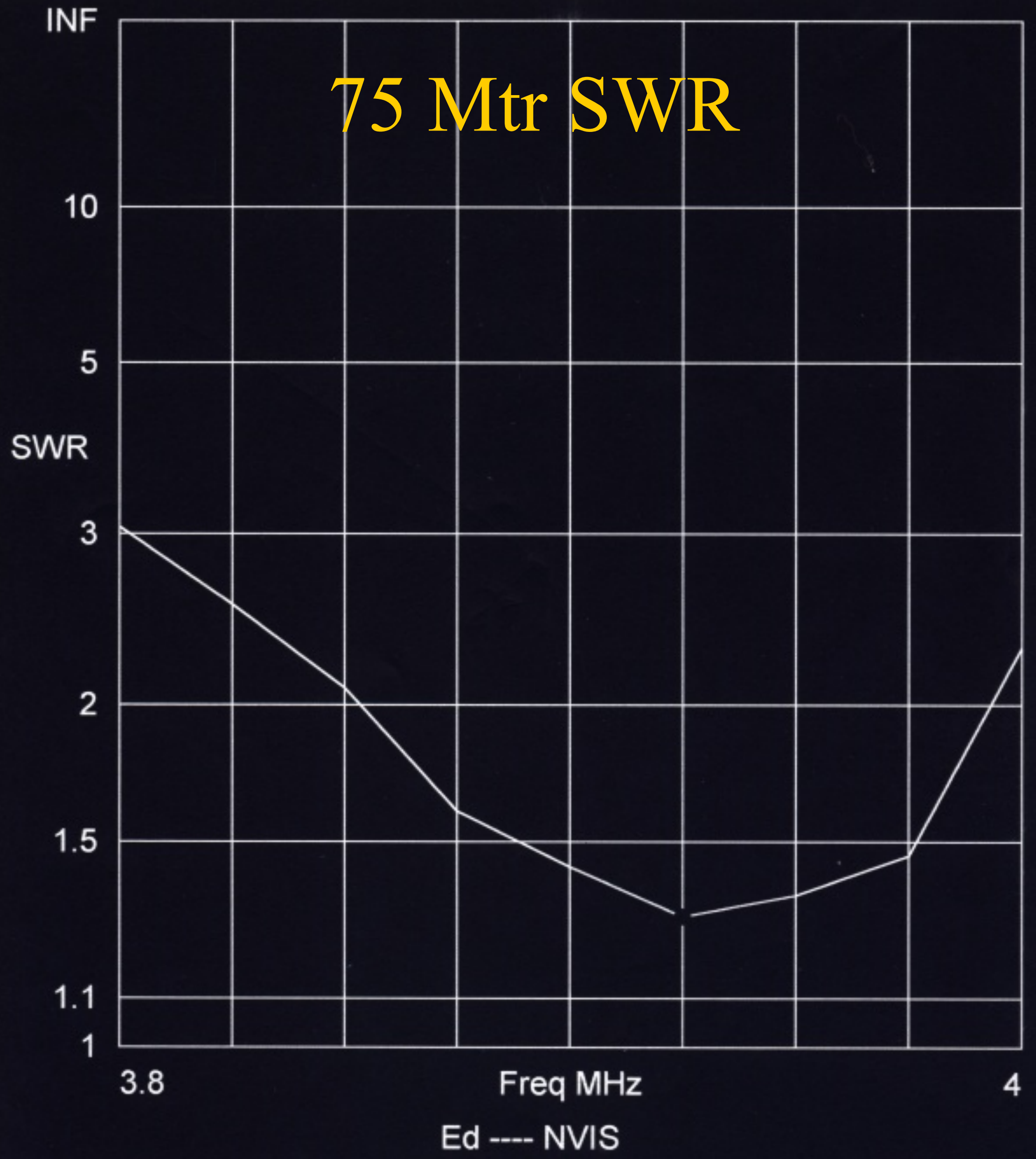
Element lengths

- 75 Mtr leg = 58.32 ft
- 40 Mtr leg = 34.08 ft
- Counterpoise = 29.66 ft

Field Day 2002

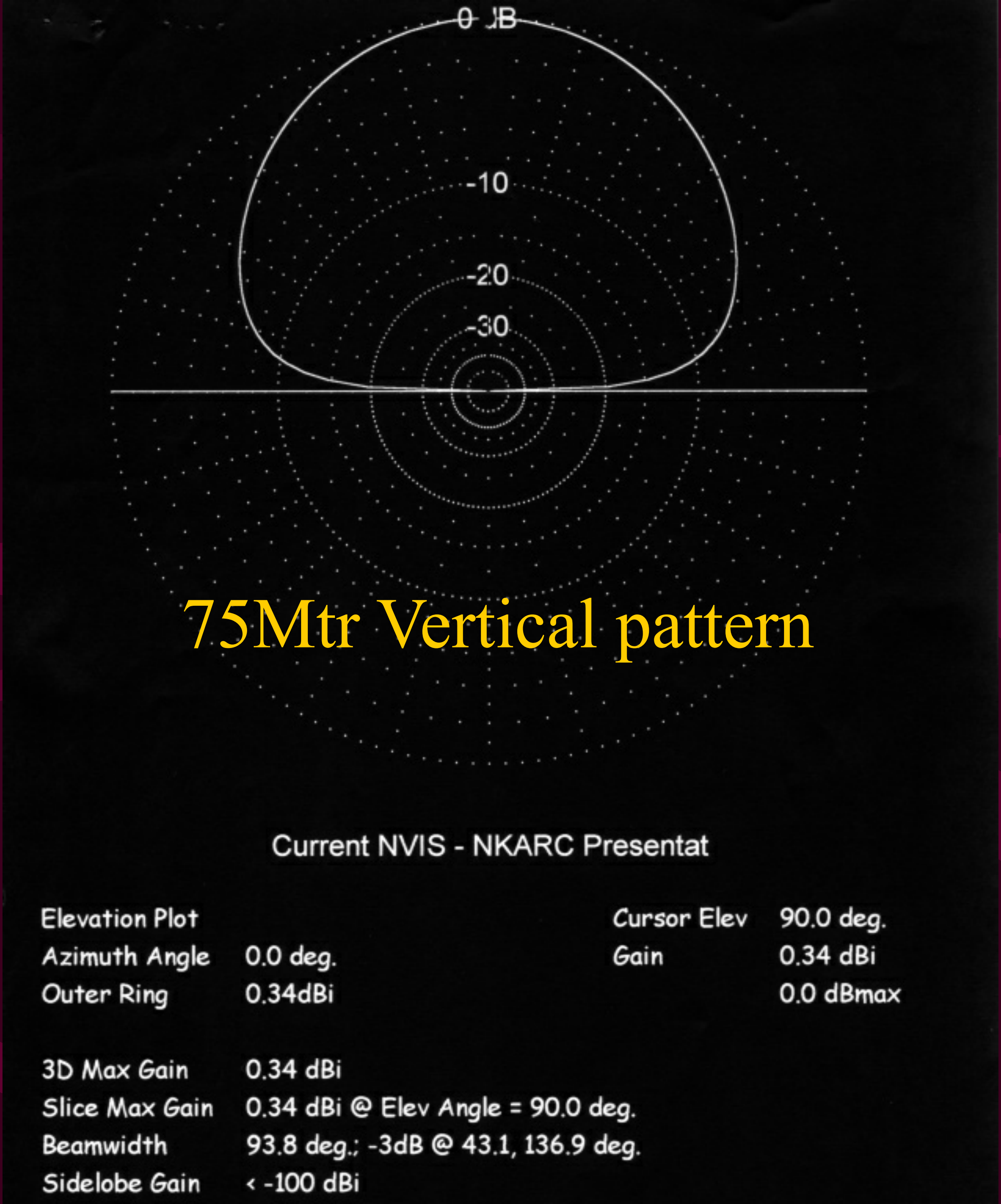
6 23 '02

75 Mtr SWR



Freq	3.925 MHz	Source #	1
SWR	1.29	Z0	50 ohms
Z	39.32 - j 3.918 ohms		

75Mtr Vertical pattern



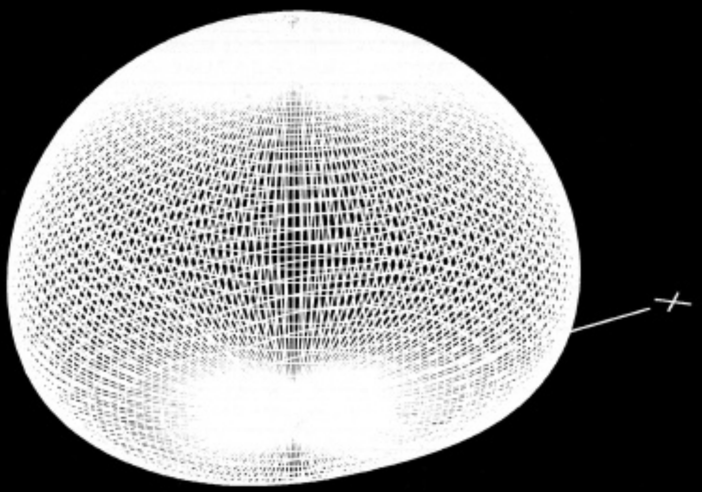
Current NVIS - NKARC Presentat

Elevation Plot		Cursor Elev	90.0 deg.
Azimuth Angle	0.0 deg.	Gain	0.34 dBi
Outer Ring	0.34dBi		0.0 dBmax

3D Max Gain	0.34 dBi
Slice Max Gain	0.34 dBi @ Elev Angle = 90.0 deg.
Beamwidth	93.8 deg.; -3dB @ 43.1, 136.9 deg.
Sidelobe Gain	< -100 dBi

Propagation Considerations

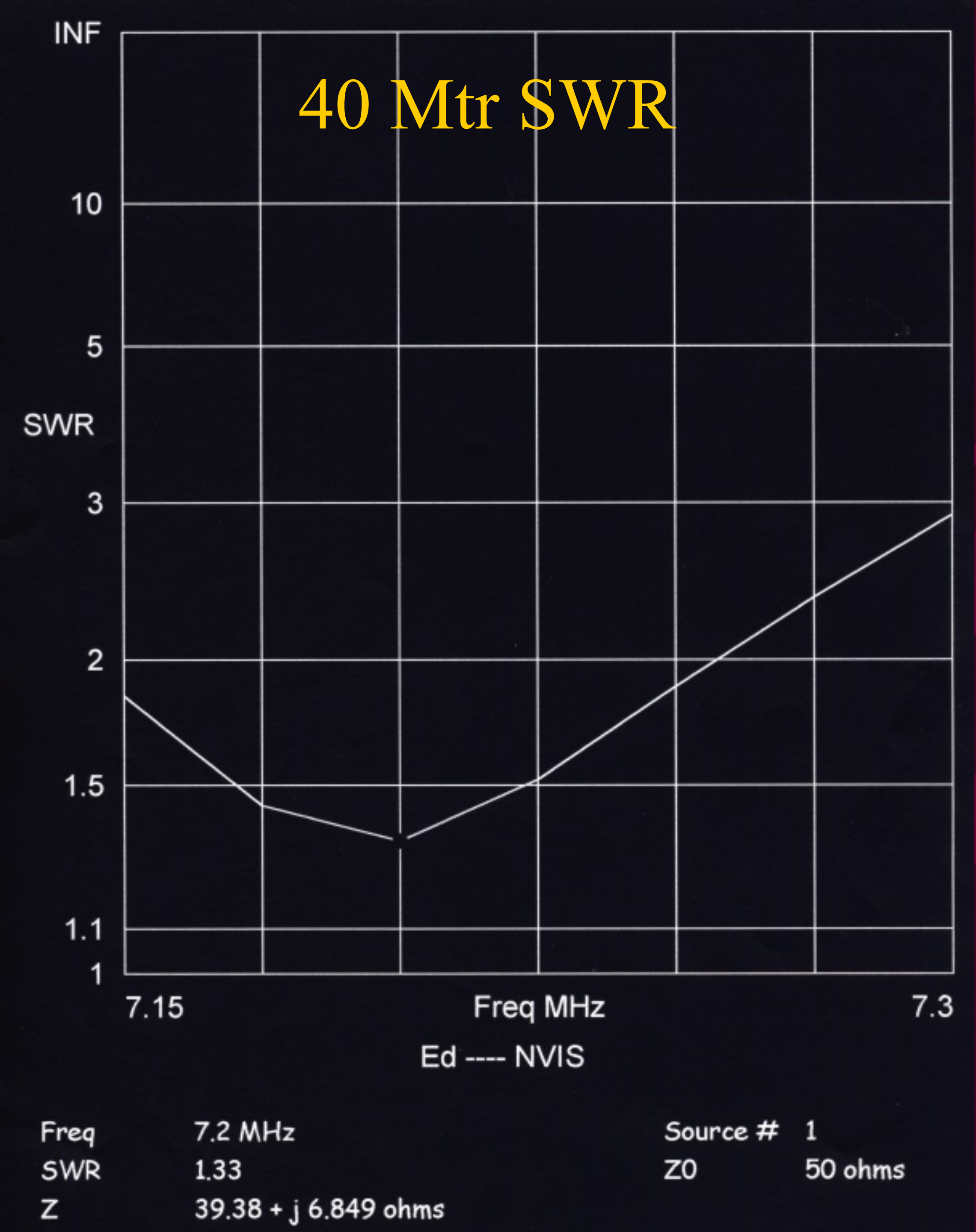
- “D” layer losses
- Ionospheric scattering for vertical propagation
- Importance of critical frequency



Omni Pattern

Ed ---- NVIS

40 Mtr SWR



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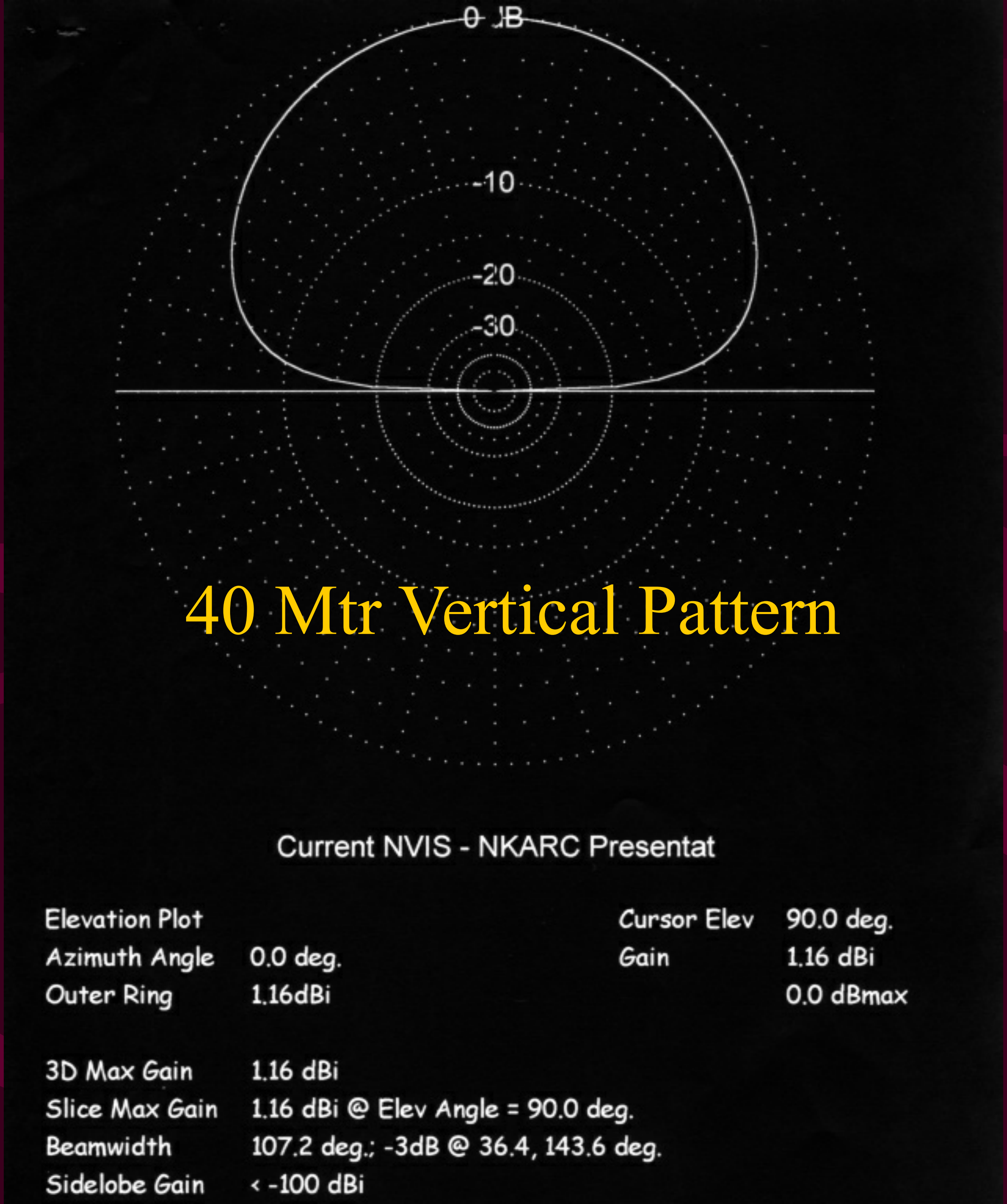
Freq     7.2 MHz                         Source #   1
SWR      1.33                            Z0         50 ohms
Z        39.38 + j 6.849 ohms
```

40 Mtr Vertical Pattern



Current NVIS - NKARC Presentat

```
Elevation Plot                                  Cursor Elev    90.0 deg.
Azimuth Angle     0.0 deg.                      Gain           1.16 dBi
Outer Ring        1.16dBi                                      0.0 dBmax

3D Max Gain       1.16 dBi
Slice Max Gain    1.16 dBi @ Elev Angle = 90.0 deg.
Beamwidth         107.2 deg.; -3dB @ 36.4, 143.6 deg.
Sidelobe Gain     < -100 dBi
```

75 Meter SWR Analyzer Data

4030	2.5
3987	2.0
3960	1.7
3923	1.5
3880	1.2
3838	1.1
3785	1.2
3749	1.5
3715	1.7
3691	2.0
3645	2.5

40 Meter SWR Analyzer Data

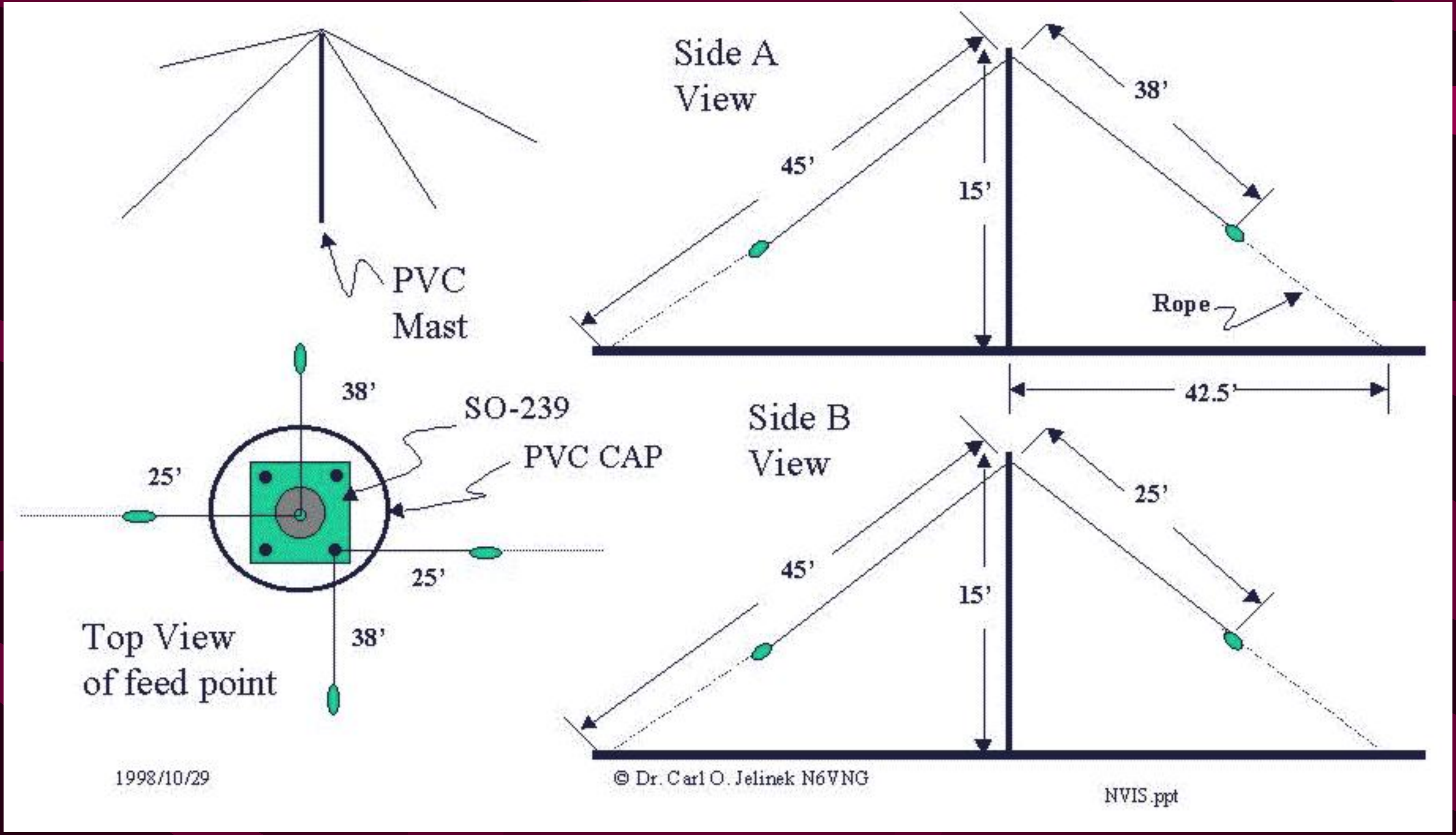
7357	2.5
7250	2.0
7210	1.7
7125	1.5
7080	1.2
7000	1.0

6990	1.2
6920	1.5
6885	1.7
6860	2.0

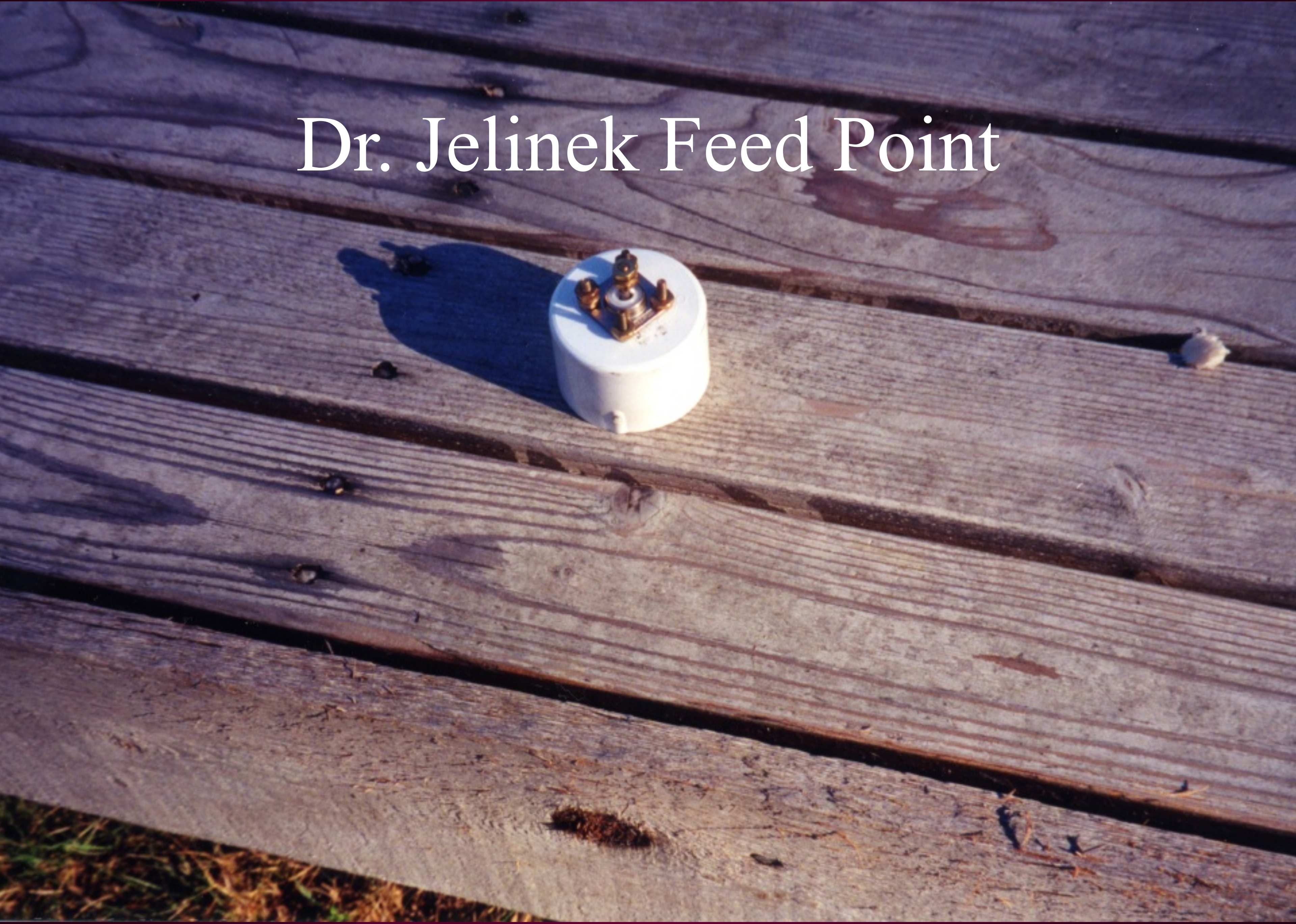
How it went together

- Materials
- Construction
- Modifications

Drawing of original concept



Dr. Jelinek Feed Point



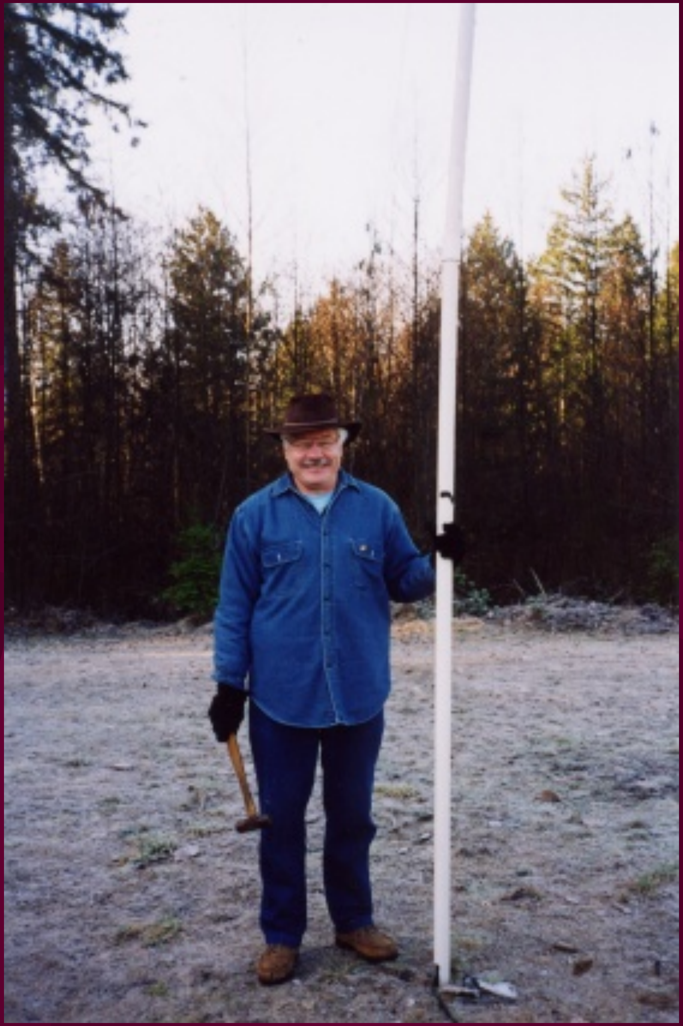
Parts list

- 2 1.5 in x 10 ft Schedule 40 PVC pipe – cut to 7.5 ft lengths
- 1 1.5 in. slip coupler (joint connector)
- 2 1 in x 10 ft Schedule 40 PVC pipe – cut to 2.5 ft lengths (6 ea needed)
- 6 1 in end caps
- 6 5/8 in Schedule 20 PVC pipe – Cut to 6 in lengths – Drill hole for wire (6 ea needed)
- 1 6 ft “T” fence post

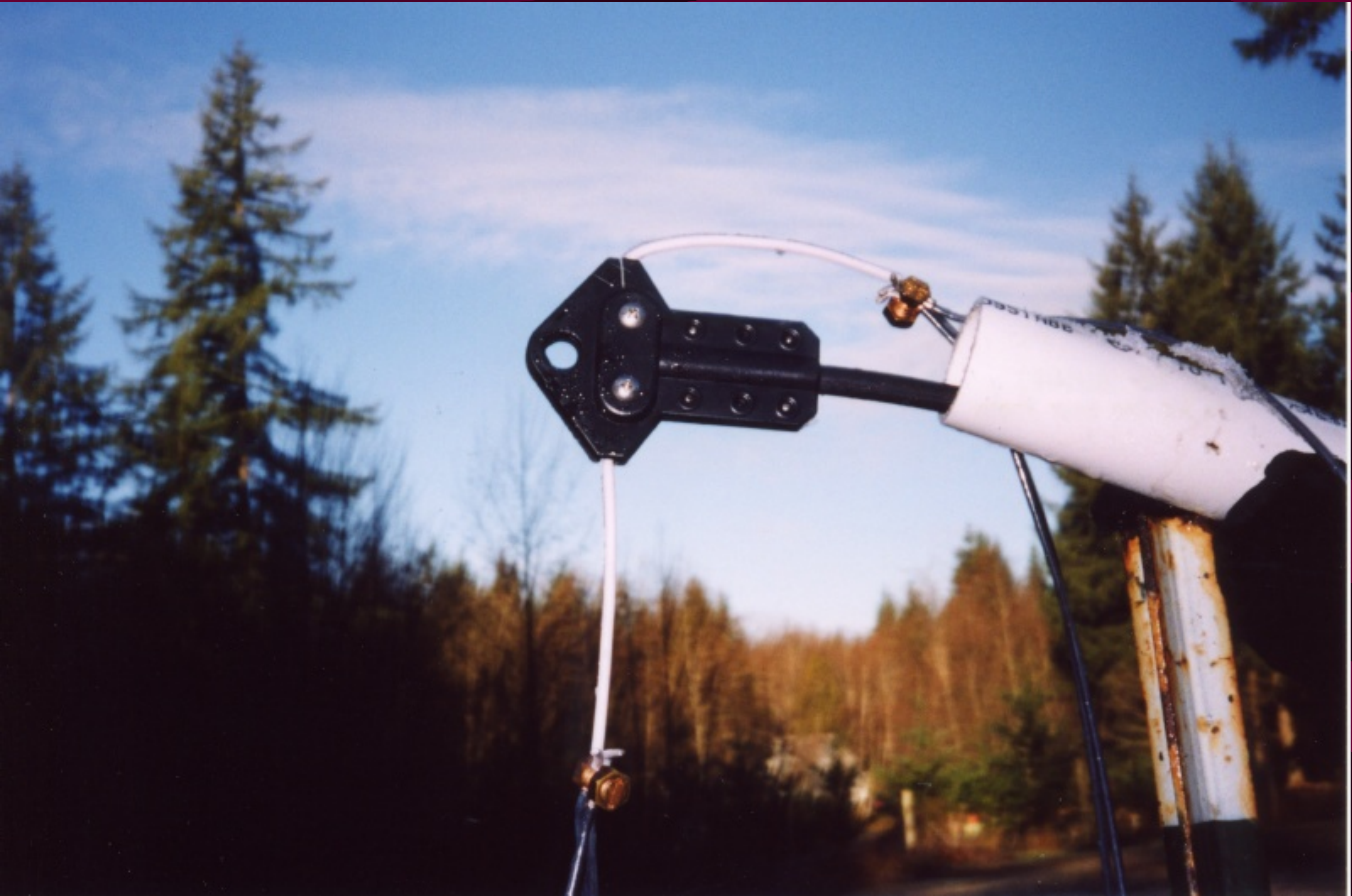
Parts list (Cont.)

- 6 18 in metal stakes
- 1 Coax Grabber
- 250 ft antenna wire
- 2 6 in. wire pig tails – transition from Coax Grabber to wire elements
- 2 Split bolts
- Coax to reach the transmitter

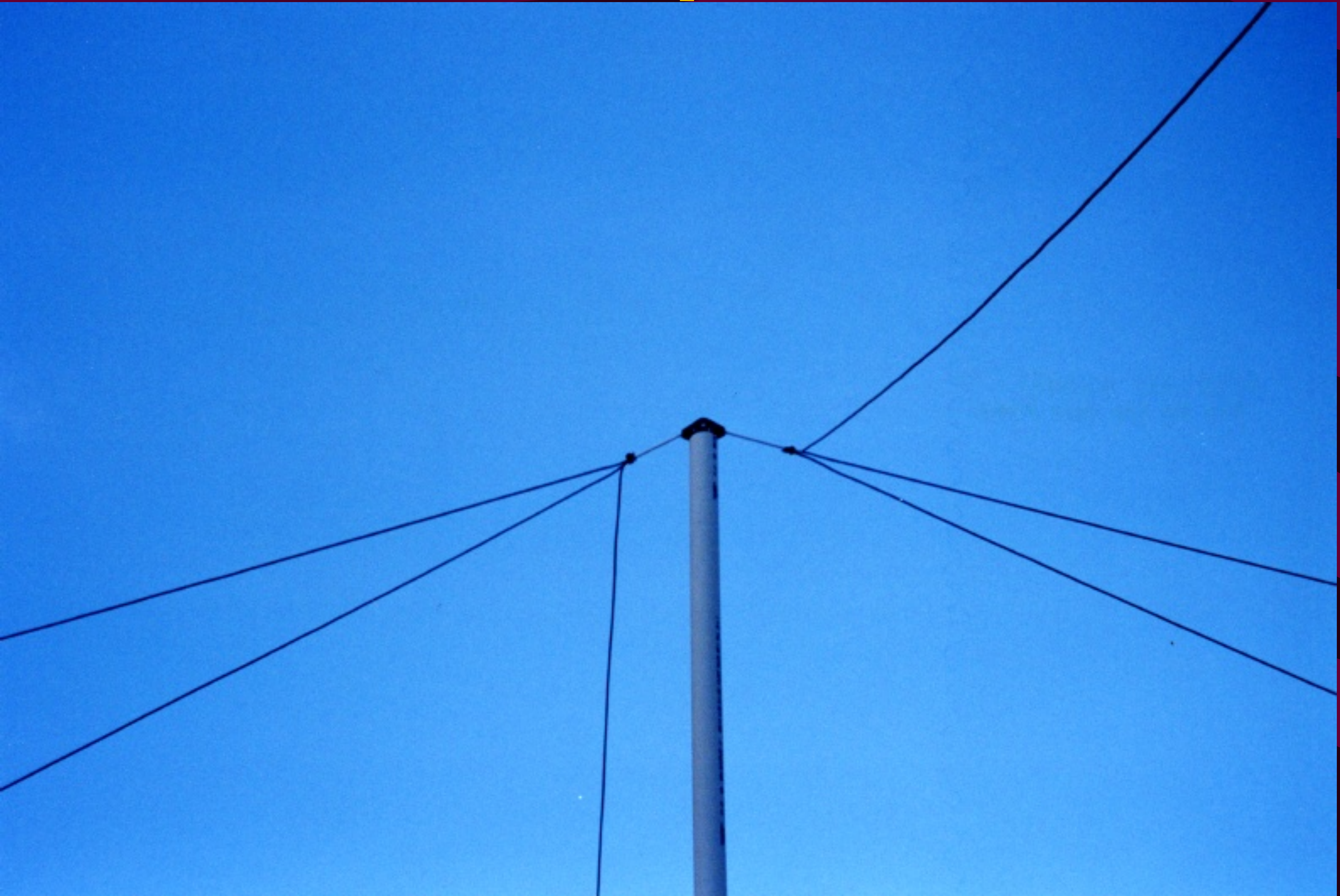
15’ center support



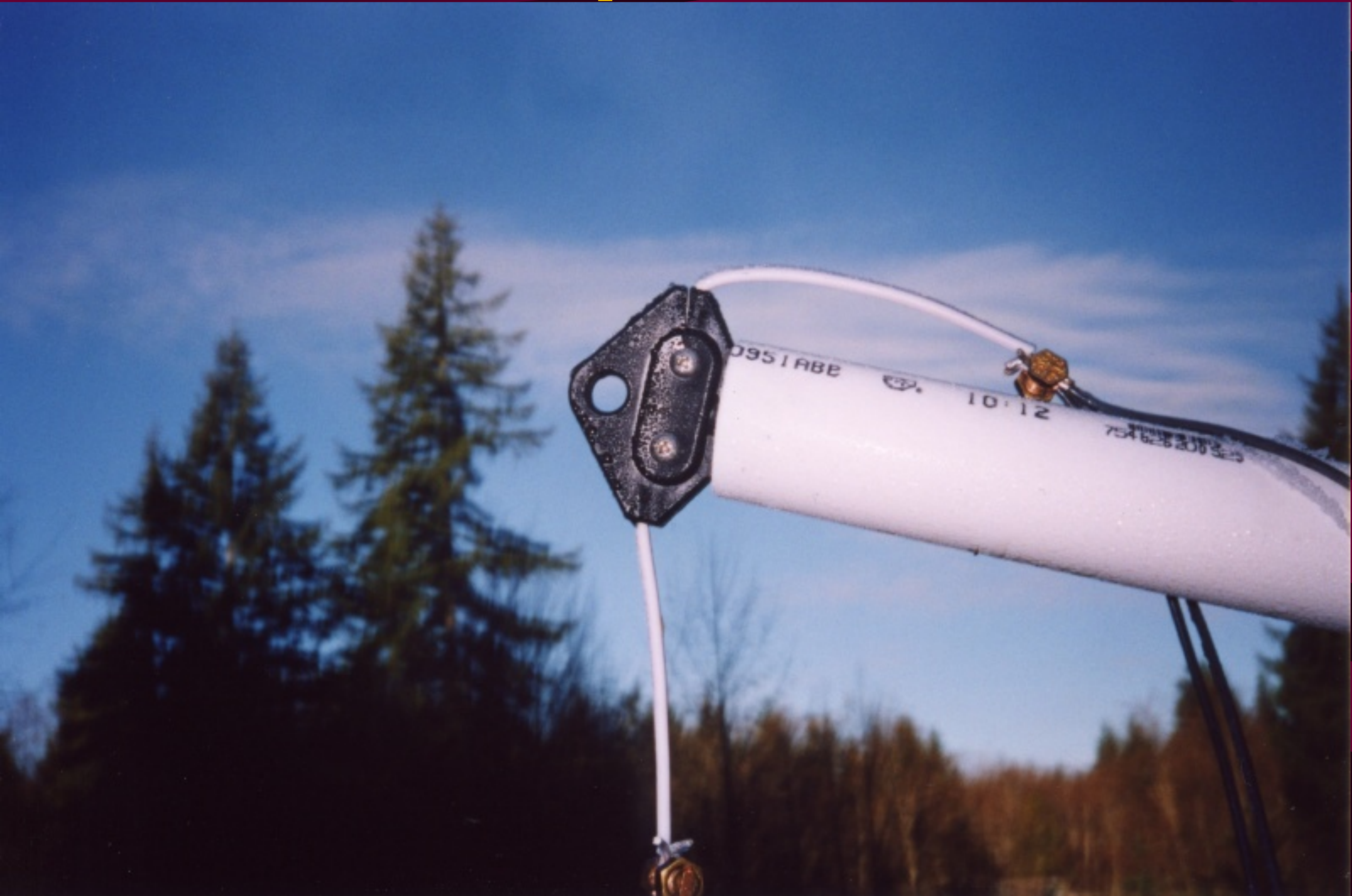
Coax Grabber

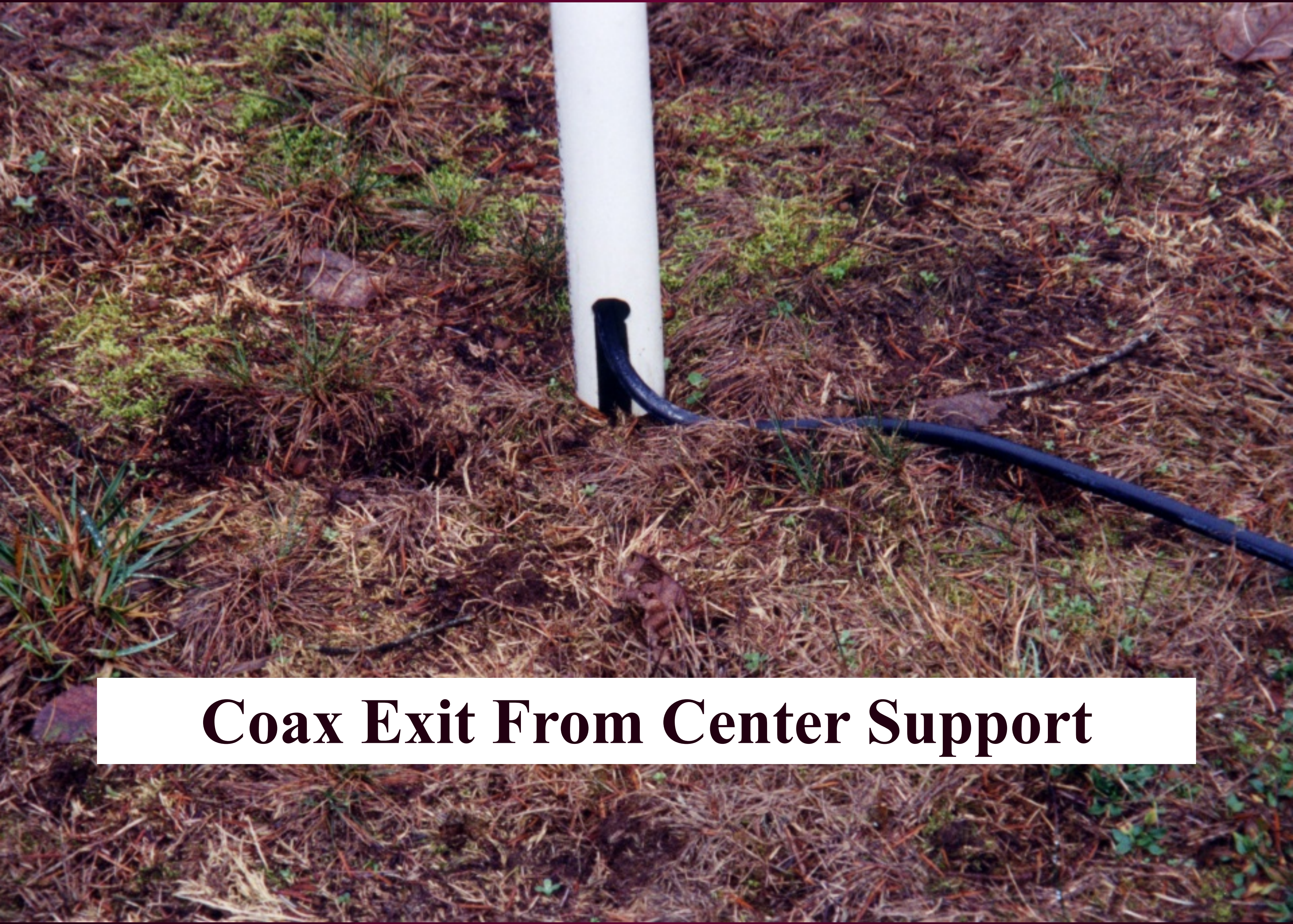


Feed point



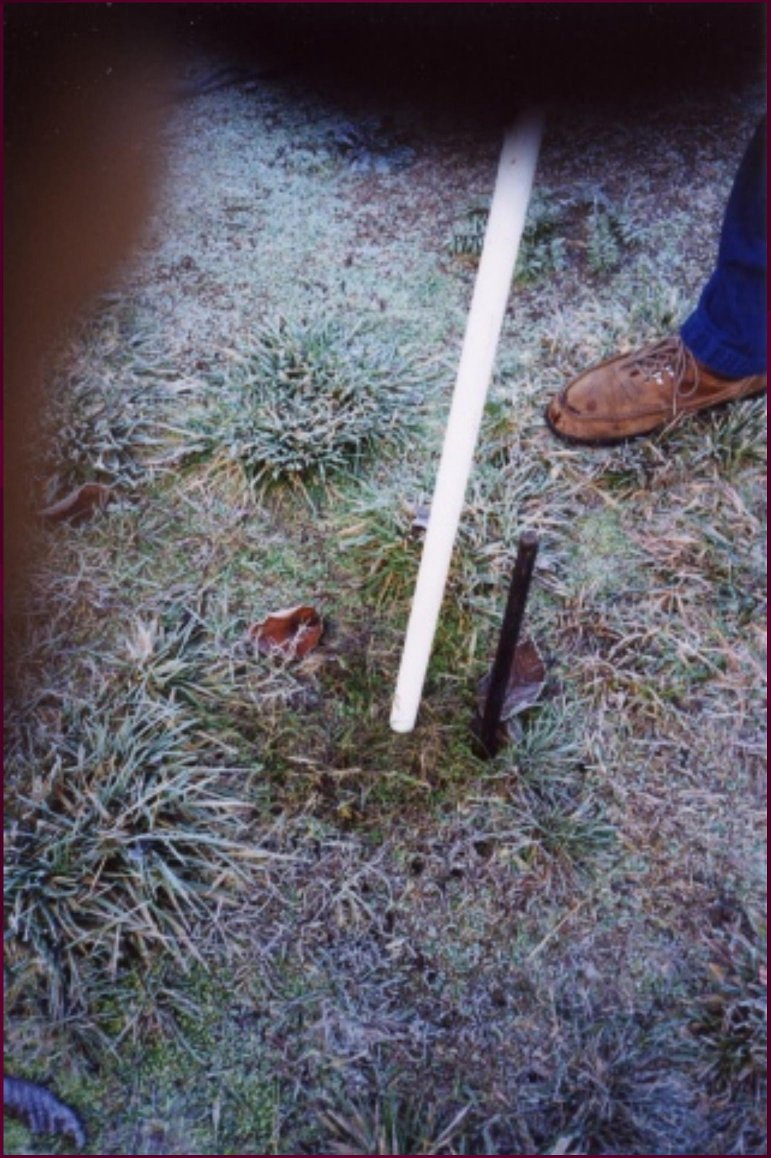
Split bolt





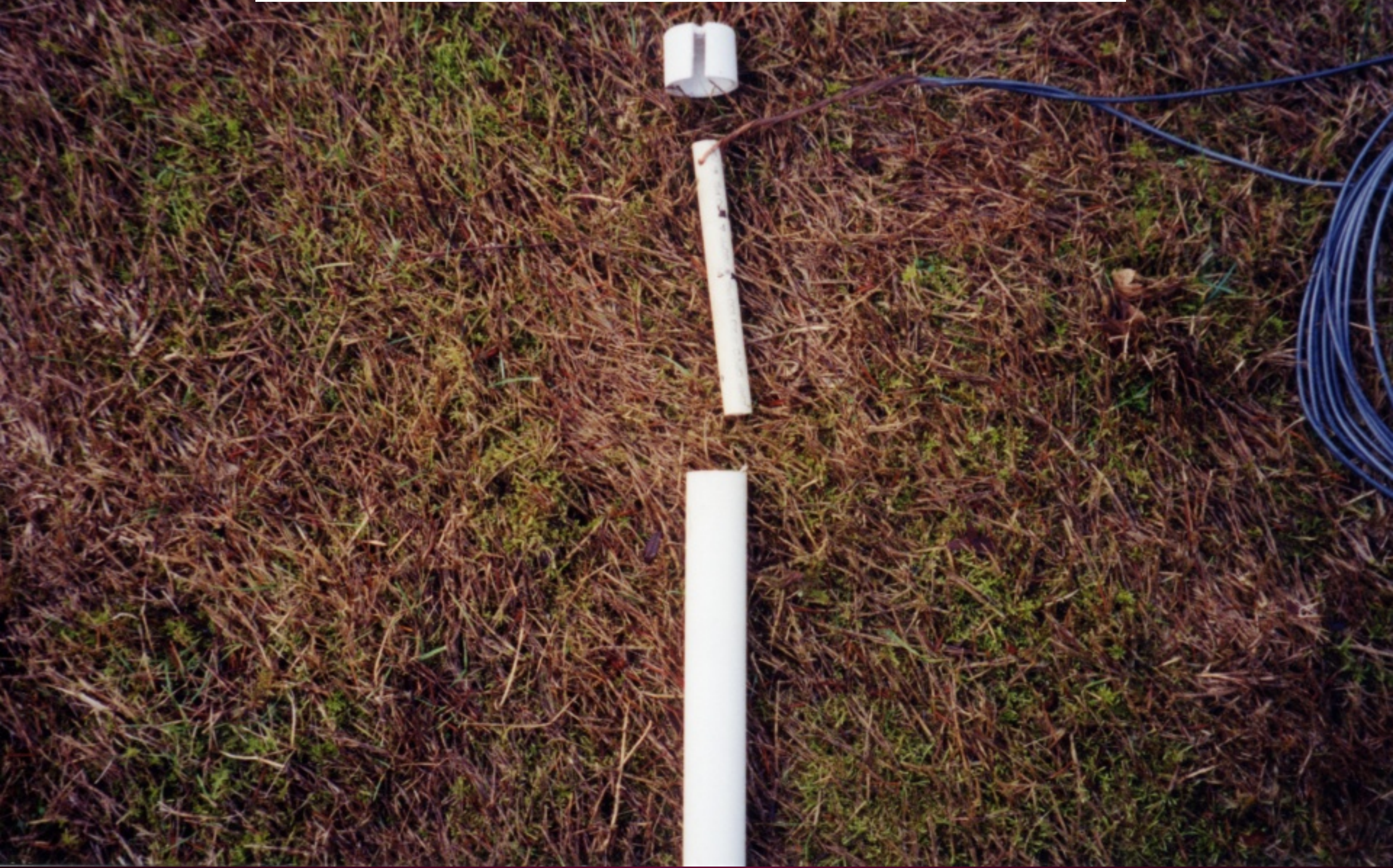
Coax Exit From Center Support

2.5’ end support and 18” stake

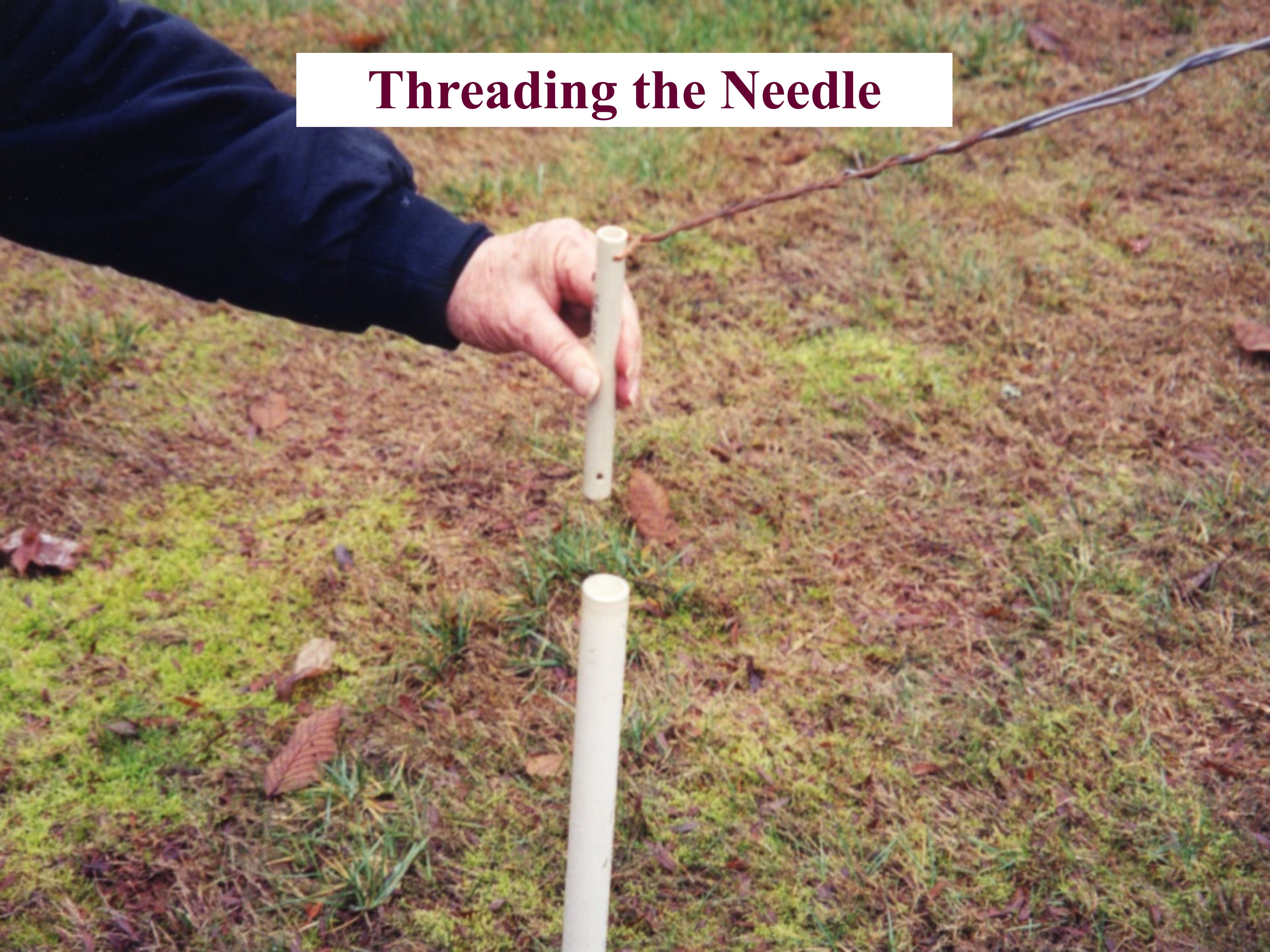


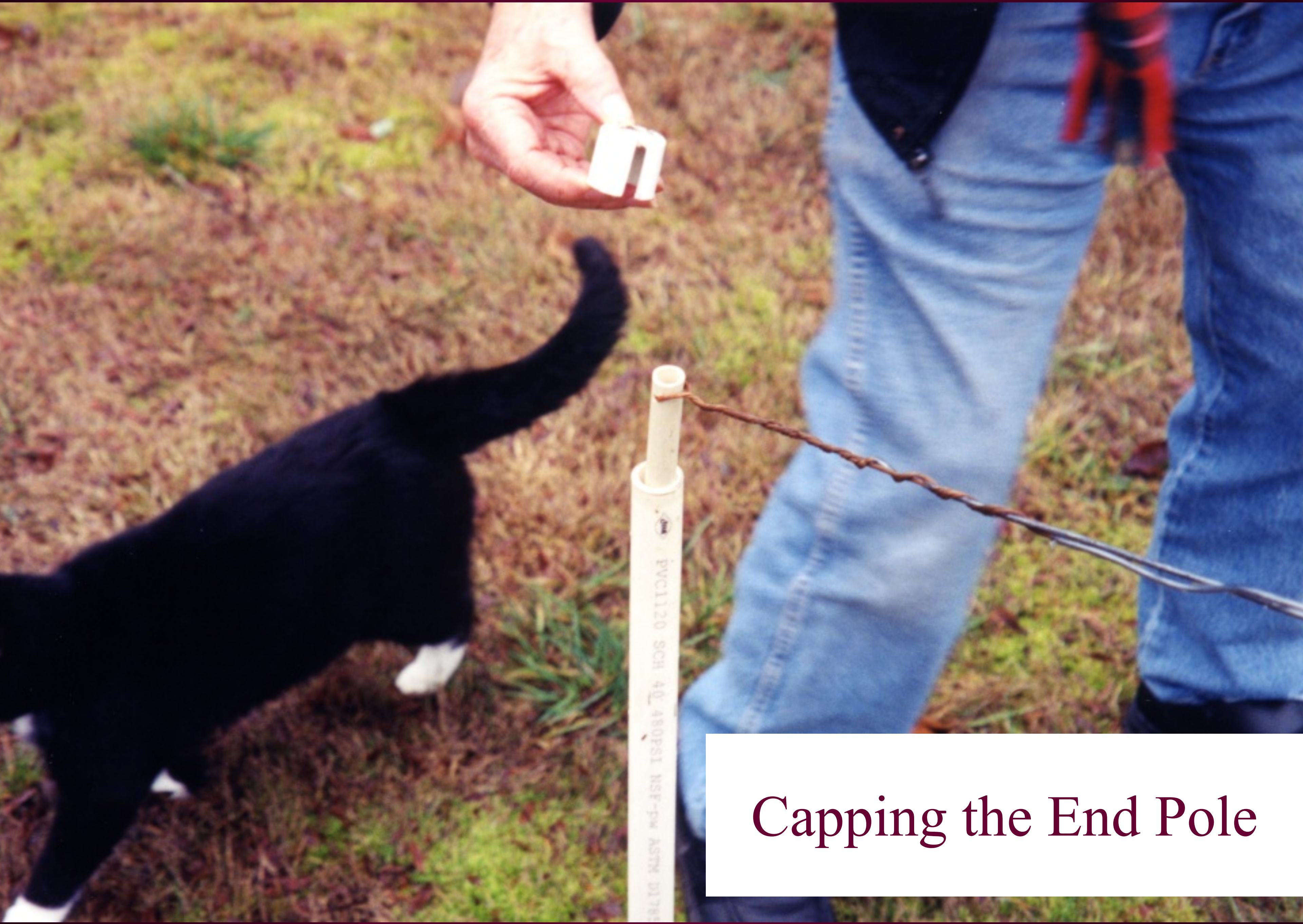
Slipping a pole over the stake

End pole assembly

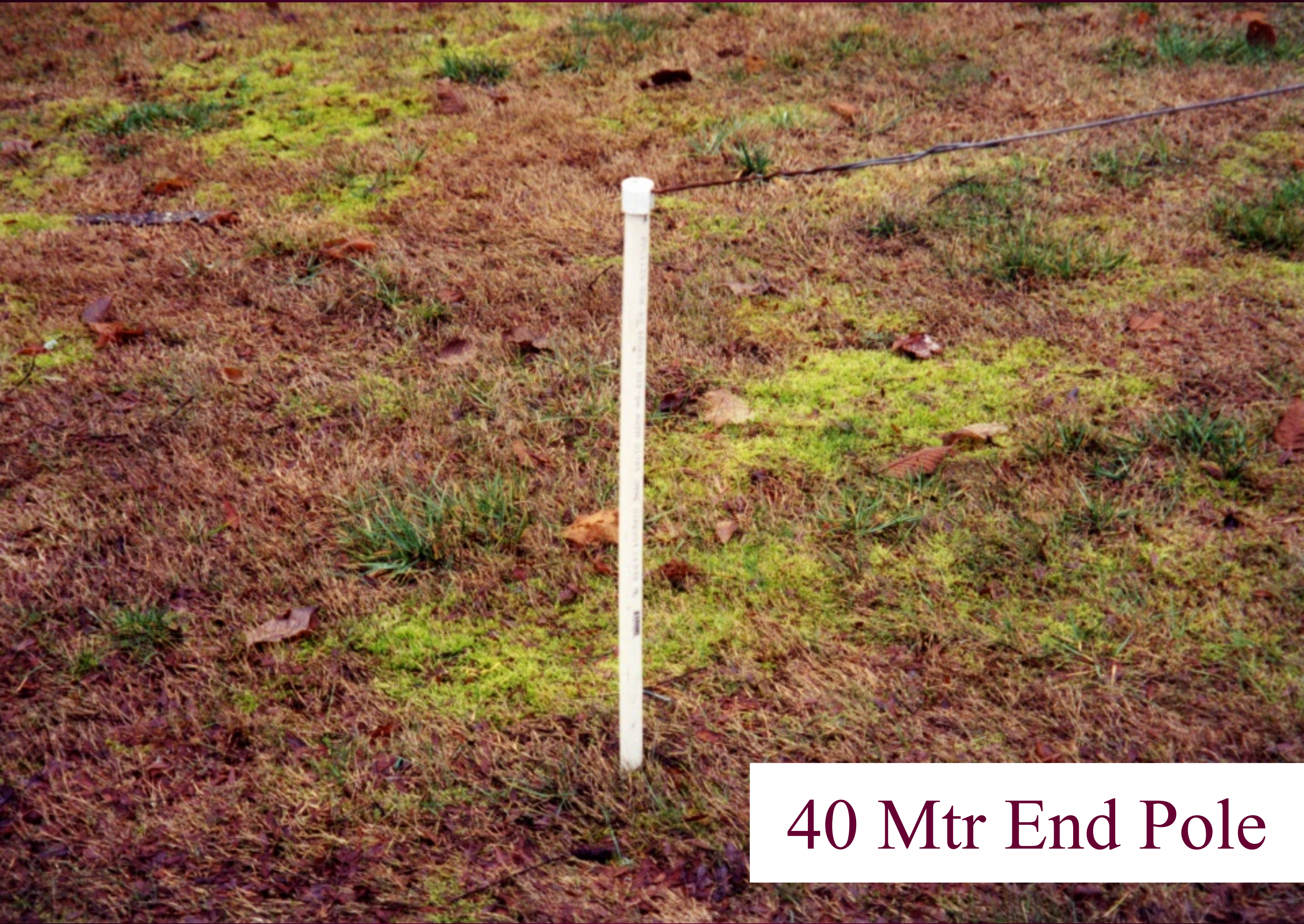


Threading the Needle



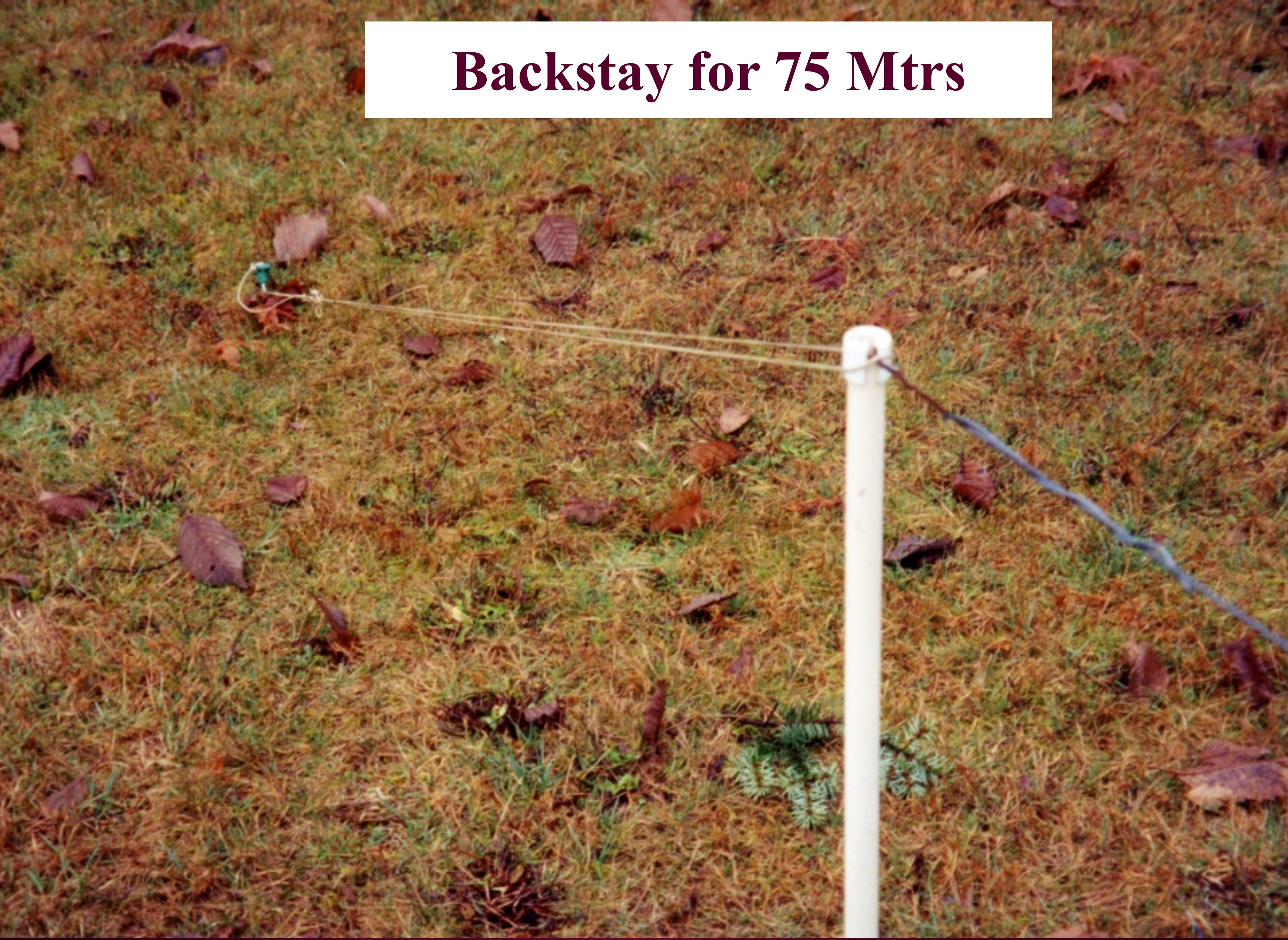


Capping the End Pole

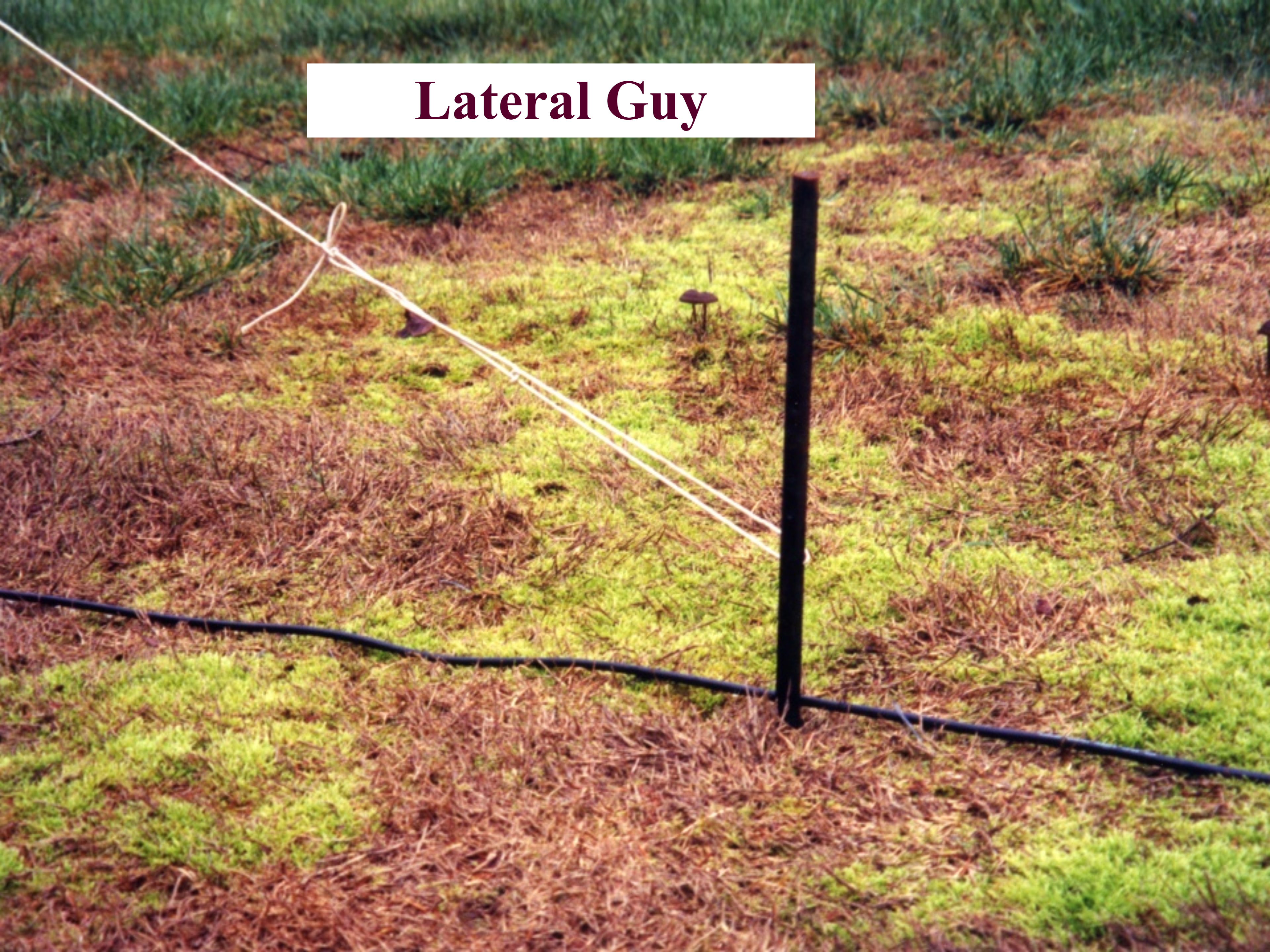


40 Mtr End Pole

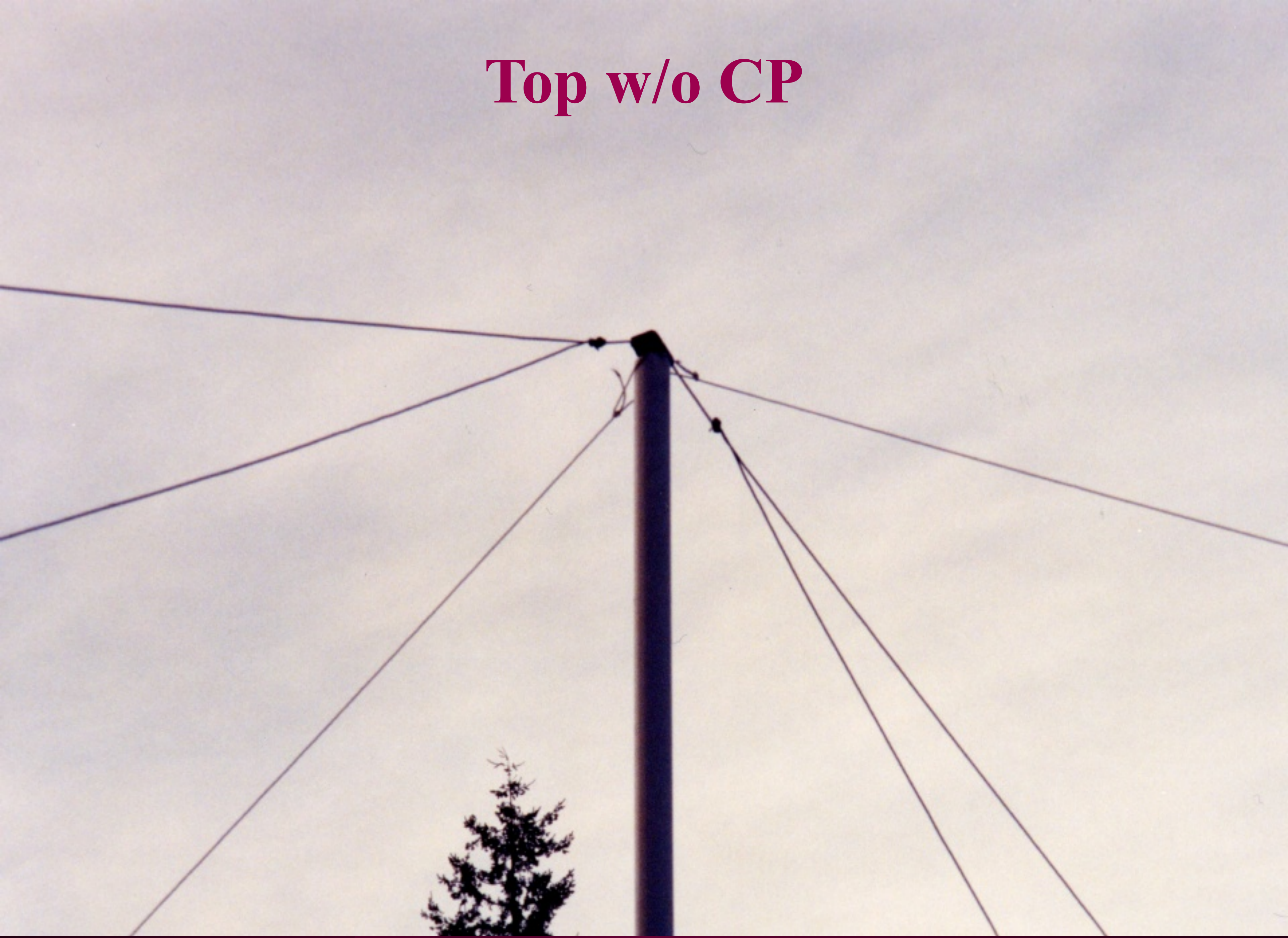
Backstay for 75 Mtrs



Lateral Guy



Top w/o CP



Tom in the RF Field

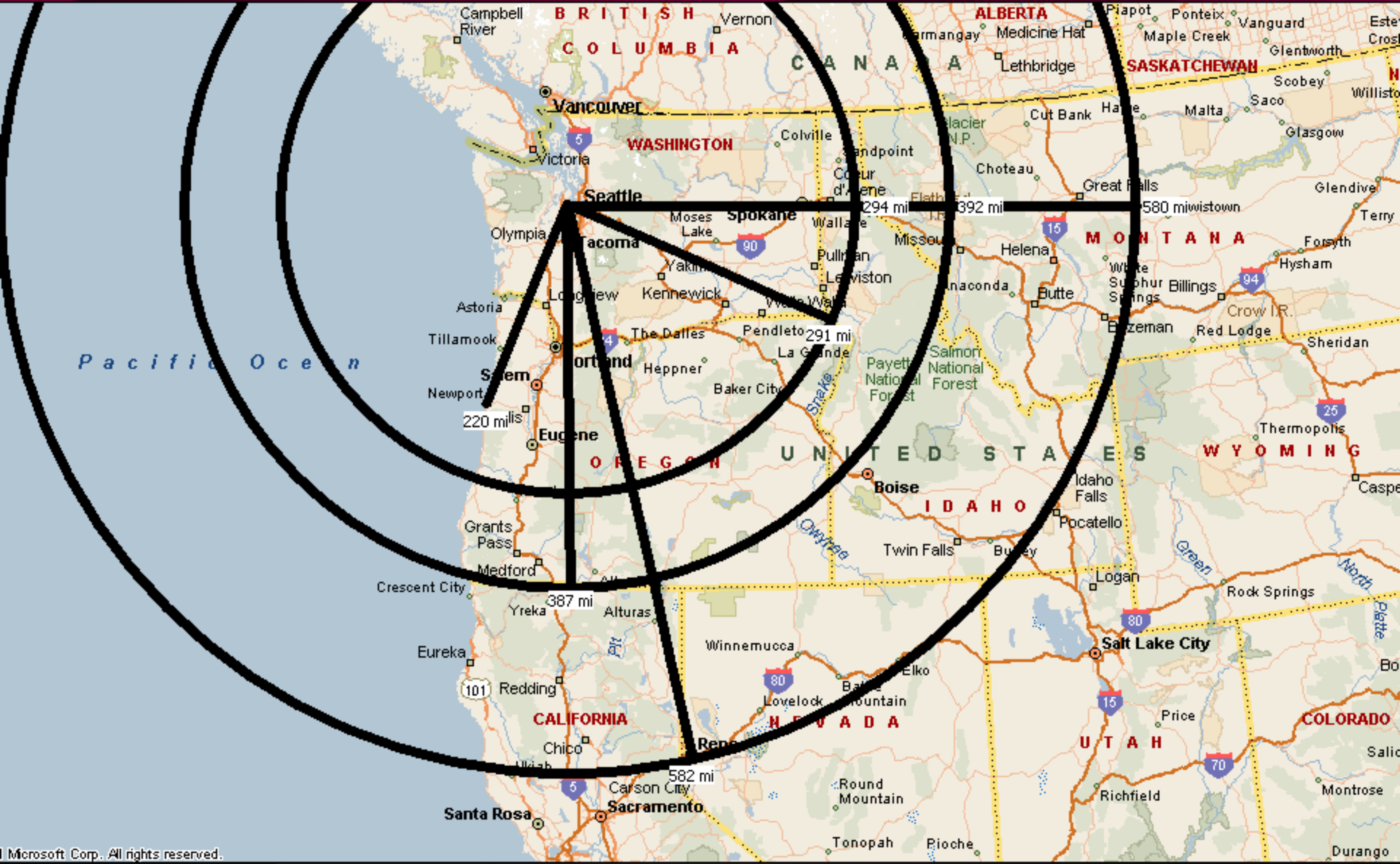
Does it work?

- Ed – Like gang busters!
- Tom – S meter pin buster!
- Field Day – Proved the theory. Worked WA, OR, ID, MT and CA as for South as Orange Co. Heard stations outside that radius but couldn’t work them
- Day to day operations – Not bothered by distant stations as much as those with higher antennas

Beamwidth

- 75 Mtrs 43 deg. To 137 deg.
- 40 Mtrs 36 deg. To 144 deg.

75 & 40 Mtr Coverage



Does it work? (cont.)

- Slight resonant frequency shift with wet vs. dry conditions – lower when wet
- Meets requirement for single person operation
- Portability enhanced with use of non-tangling wire
- Permanent installations need to be reinforced against the wind

Tools required

- Hammer
- Adjustable crescent wrench
- That’s it! There ain’t no mo!

Hints & tips

- Tin the feed point end of the wire – better fit for the split bolt
- Coax Grabber has a hole in the top for suspension from a tree or other support structure/device
- When using suspension method, put 15’ mark on coax to ID the proper height
- Coax should be perpendicular to the ground
- Can be inverted “V” configuration

Safety considerations

- Flag end of wire – RF burn
- Flag lower portions of wire for choking hazard
- Insulated wire reduces possibility of RF burns
- Black feline required to protect winged critters from unfriendly RF environment

Thank you!

de Ed & Tom